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Evaporative Process for Treatment of Phosphate Containing Effluent

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A unique evaporation/humidification process for treating wastewater effluent has been developed at Alcoa Laboratories. A major portion of the effluent is recovered as water of high purity suitable for recycle or reuse, and the small volume of concentrated chemicals can be either recycled or easily disposed of. The process operates at low temperatures and near-atmospheric pressures. Low pressure steam generated from waste heat is sufficient to operate it. A 75,000 L/day pilot plant was installed at Alcoa's Warrick County, Indiana, plant to demonstrate the performance and reliability of the process for treatment of dilute, phosphate-containing effluent. The installation was placed in service in January 1975, and operated on a non-continuous basis until October 1975. During this time various problems were solved and optimum operating conditions were established. The average effluent treatment rate was 71,200 L/day and excellent quality water was obtained. The system operated satisfactorily when effluent and steam were available. Tests at Alcoa Laboratories showed that the product condensate can be used as rinse water at the phosphate cleaning lines in place of deionized water, and the concentrated phosphate blowdown can be recycled as make-up to the phosphate cleaning solution.

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EVAPORATIVE PROCESS FOR TREATMENT OF PHOSPHATE CONTAINING EFFLUENT

by

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-CI) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

These studies were undertaken to demonstrate the performance and reliability of a new, evaporative process for treatment of dilute, phosphate-containing effluent. A large, pilot-scale installation was built at Alcoa's Warrick County, Indiana plant and tested on actual, phosphate-containing effluent from aluminum coil cleaning operation. This process offers a substantial saving in money and energy by recovering water and chemicals from the wastewater effluent while operating from waste stack gas heat. This system can be used for handling low-concentration wastewater effluents from many industrial processes where high purity water and/or chemical recovery for recycling is desired, or simply for reducing the total volume of effluent to facilitate waste disposal.

Such information will be of value both to EPA's regulatory program (Effluent Guidelines Division) and to industry itself in arriving at meaningful and achievable discharge levels. Within EPA's R&D program the information will be used as part of the continuing program to develop and evaluate improved and cost effective technology to minimize industrial waste discharges.

For further information concerning this subject the Industrial Pollution Control Division should be contacted.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

A unique evaporation/humidification process for treating wastewater effluent has been developed at Alcoa Laboratories. A major portion of the effluent is recovered as water of high purity, suitable for recycle or reuse; the small volume of concentrated chemicals can be either recycled or disposed of easily. The process operates at low temperatures and near-atmospheric pressures. Low pressure steam generated from waste heat is sufficient for its operation.

A 75,700 L/day (20,000 gal/day) pilot plant was installed at Alcoa's Warrick County, Indiana Plant to demonstrate the performance and reliability of the process for treatment of a dilute, phosphate-containing effluent. The installation was placed in service in January, 1975 and operated on a non-continuous basis until October, 1975. During this time various problems were solved and optimum operating conditions were established.

The average effluent treatment rate was 71,200 L/day (18,800 gal/day) and excellent quality water was obtained. The system operated satisfactorily when effluent and steam were available. Tests at Alcoa Laboratories showed that the product condensate can be used as rinse water at the phosphate cleaning lines in place of deionized water, and the concentrated phosphate blowdown can be recycled as make-up to the phosphate cleaning solution.

This report was submitted in fulfillment of EPA Grant S-803261-01-4 by Alcoa Laboratories under the partial sponsorship of the U. S. Environmental Protection Agency. This report covers the period January 3, 1975 to October 3, 1975 and work was completed as of January 27, 1976

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SECTION 1

INTRODUCTION

Waste treatment technology is constantly evolving in response to changing requirements of society. As society raises water quality standards and new production levels create additional and different wastes, new technology must be introduced to treat, alter or reuse these wastes.

Industry produces many dilute aqueous wastes that are both difficult and costly to treat in order to meet the effluent quality standards required by current environmental guidelines. The ultimate goal is "zero discharge" by 1985. In addition, the guidelines are often being changed as effects of wastes upon the environment are documented.

In 1970 the Aluminum Company of America embarked upon a program to apply previous experience and patents* in desalination technology to waste treatment. The development program had the following objectives:

(1) Produce water of such quality that all future water quality standards would be met, or to achieve a quality that would permit reuse in the operation.

(2) Produce a concentrated waste that could be reused, sold as a useful product- incinerated or dried for easier disposal.

(3) Achieve net operating costs equal to or less than costs of available conventional treatment.

From this effort a patented** thermal method has been developed for treating various waste waters to produce high quality water and concentrate waste for recovery or disposal. This method has been tested on diverse wastewaters with favorable results.

The Alcoa plant at Warrick County, Indiana, produces low-concentration phosphate wastewater effluent from the rinsing area of the coil preparation line for rigid container sheet. The effluent is discharged at a pH of about 10 and at approximately 55°C (130°F). It contains between 1,000 to 5,000 mg/L of dissolved phosphate and smaller quantities of

* U.S. Patent No. 3,528,890 and 3,575,817
** U.S. Patent No. 3,822,192 and 3,843,463

aluminum hydroxide, sodium aluminates and other complexes of these elements. Approximately 200 mg/L of low viscosity mineral oil is also in the effluent. The effluent can be treated by either a standard chemical waste treatment process or by a new evaporative process (Thermopure*). The advantage of the latter process is that high quality water and phosphate can be recovered and recycled to the coil preparation lines for reuse. Also, the heat to operate the evaporative process can be obtained from steam generated from hot stack gases. Therefore, this approach would not only solve the effluent disposal problem but would also save a substantial sum of money by conserving materials and energy.

The main purpose for the installation of the evaporative process at Warrick was to demonstrate the performance and reliability of the process treating the phosphate wastewater effluent directly from the coil preparation line. The pilot plant was designed to demonstrate that water of sufficient purity for recycling as rinse water could be produced and that the effluent could be concentrated to a low volume to facilitate waste disposal. Two methods of waste disposal were considered at that time. One was landfill and the other was to utilize the phosphate content as fertilizer. Another alternative was to recycle the phosphate to the coil preparation lines. It was recognized that additional treatment, such as oil removal from the condensate or chemical treatments or drying of the phosphate concentrate, might be required; but it was felt that these processes would not have to be demonstrated since their technology was not new as was the case with the evaporative process.

The Warrick evaporative treatment installation was designed to treat 75,700 L/day (20,000 gal/day) of effluent. The all-aluminum column is 63.5 cm (25 inches) in diameter (I.D.), contains four hundred and fifty-six 1.6 cm (5/8 inch) diameter (I.D.) aluminum tubes and is 7.6 meters (25 feet) high. A schematic of the column is shown in Figure 1 and a photograph of the installation in Figure 2.

The operation of the process is shown schematically in Figure 3. Wastewater from the coil preparation lines flows through strainers to a pH adjustment tank where a pH meter monitors the solution and operates a metering pump to add sulfuric acid to neutralize the solution. This neutralized solution is pumped into the recirculating tank and then into the top of the evaporative column where it is dispersed in a large volume of air from a blower. The wastewater/air

* Trade name of the Alcoa evaporative wastewater treatment process hereafter referred to as the "process" or "evaporative process".

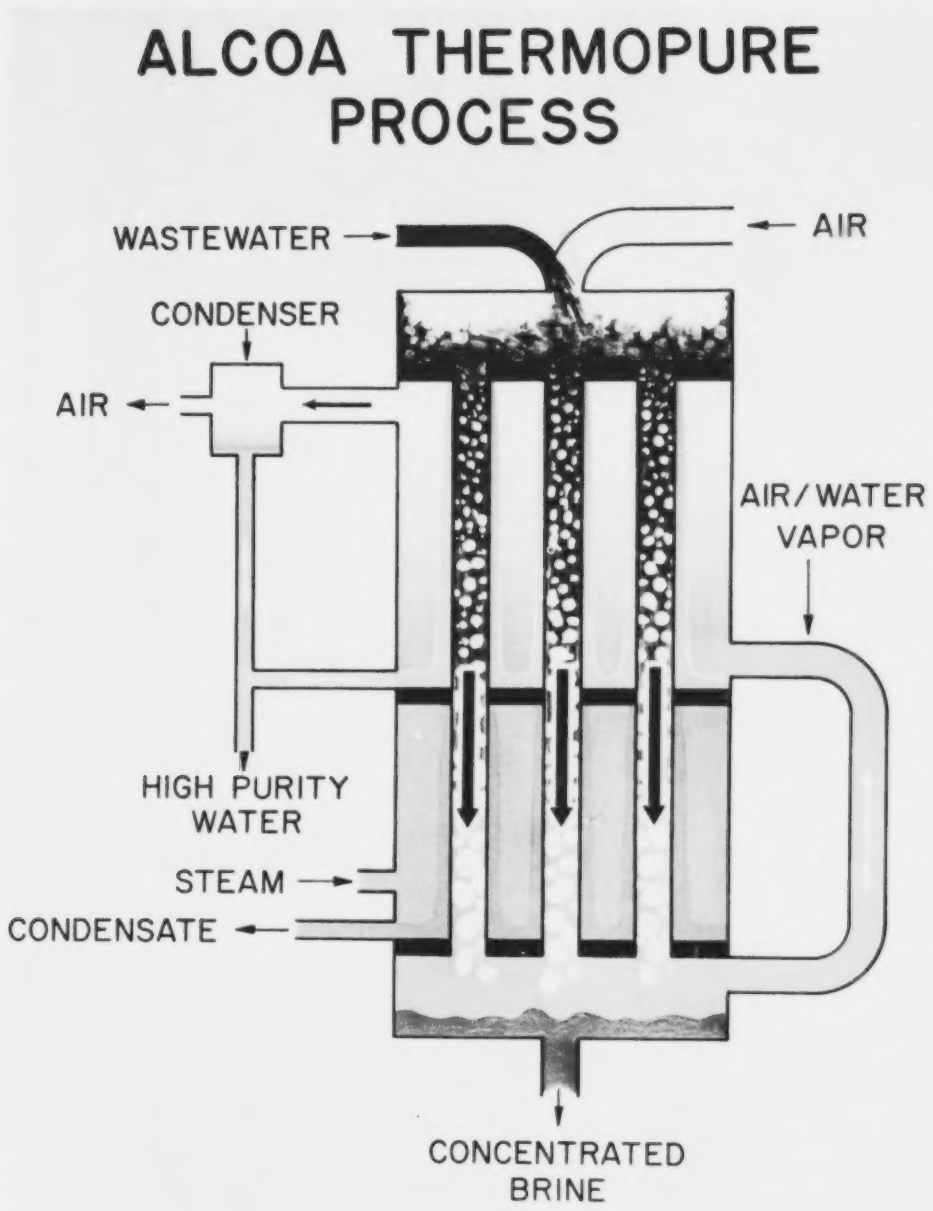

Figure 1. A schematic of the evaporative column.

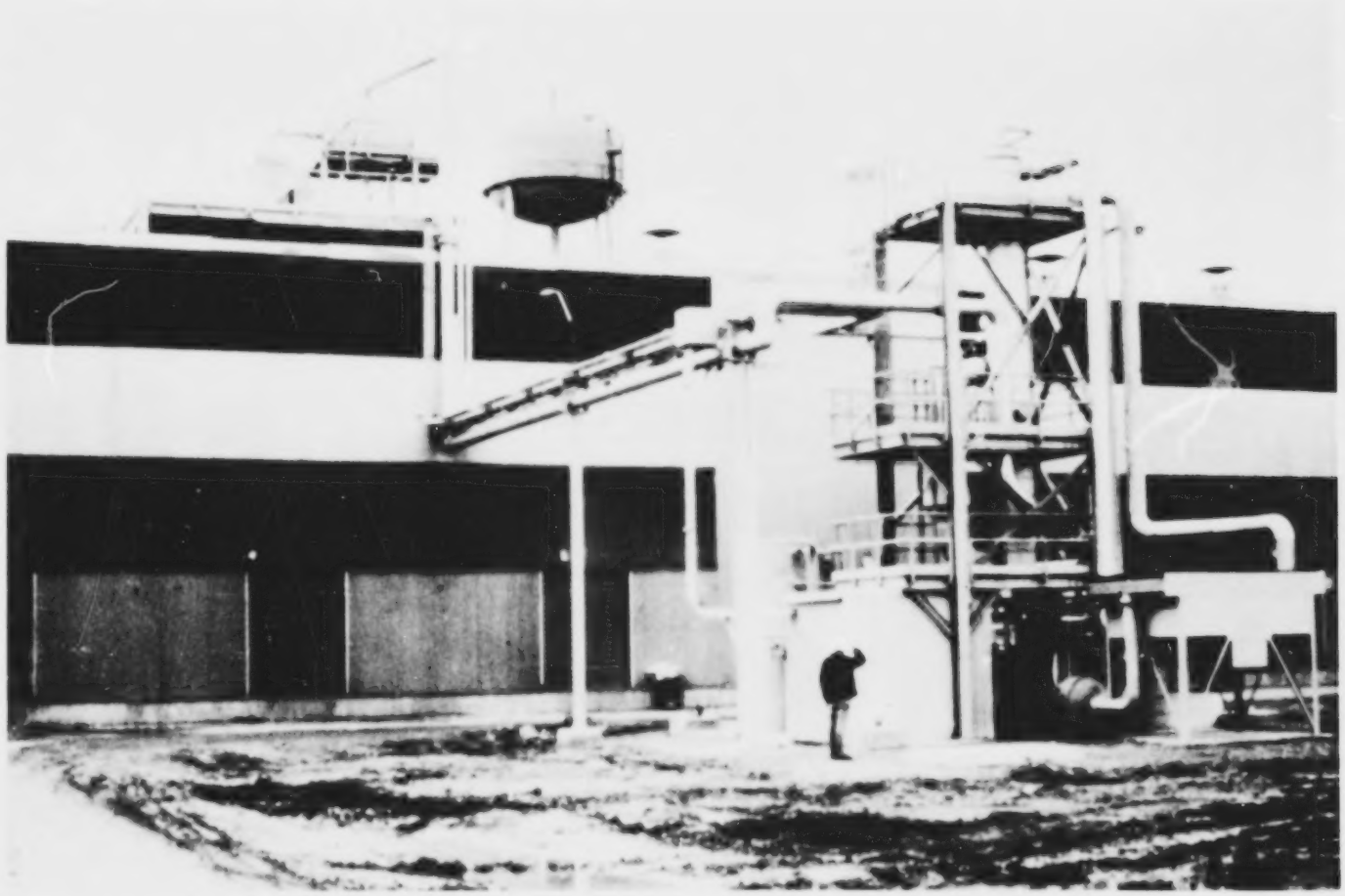

Figure 2. Photograph of the pilot plant evaporative process installation and the waste heat steam generator at Warrick.

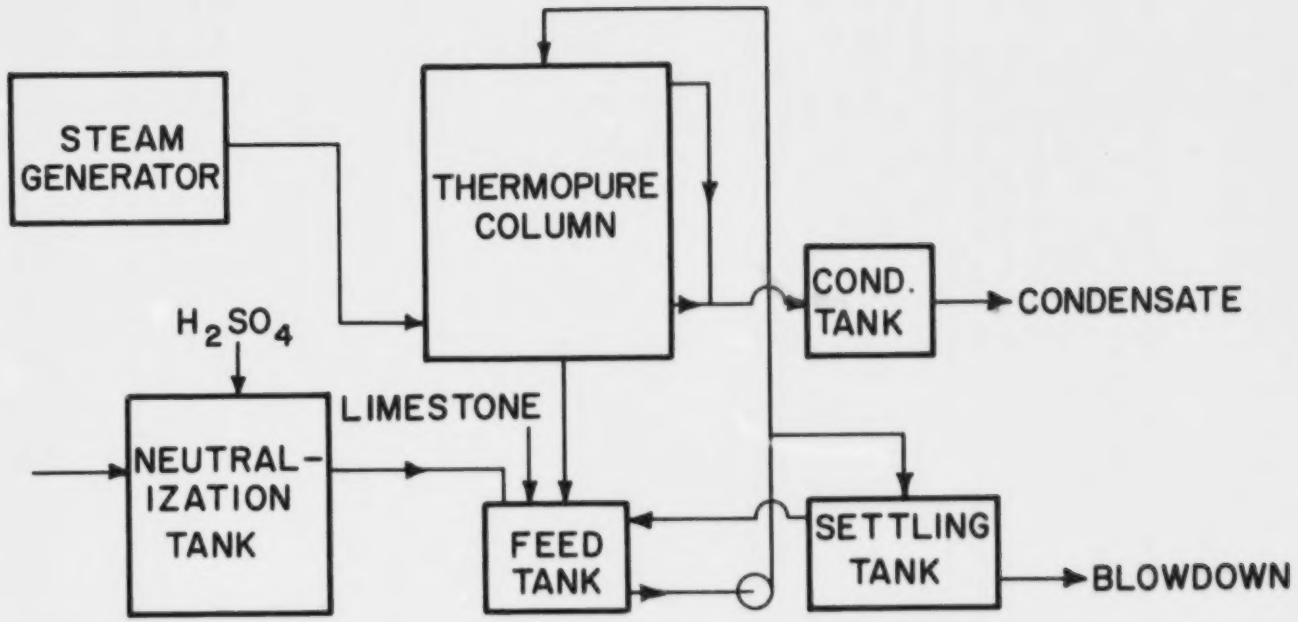

Figure 3. Flow diagram of the evaporative pilot installation.

mixture passes concurrently down the inside of the tubes, which are heated at the lower portion with 0 - 34.5 kPa (0 - 5 lb/in^2) gauge steam. As the temperature increases, the air is humidified with water vapor from the wastewater. A high velocity in the tubes maintains a good dispersion of water in air to provide a large surface area to promote rapid humidification. At the point of wastewater/air mixture discharge from the tubes, the air has absorbed a large amount of water vapor (approximately 10 to 15 per cent of the wastewater feed to the column).

This air/vapor mixture is then conducted through a bypass line, through a demister, to the exterior side of the tubes in the upper portion of the column where much of the water vapor condenses on the relatively cooler tube bundle, thereby preheating the wastewater/air mixture and increasing the amount of vapor produced inside the tubes. This routing of the air/vapor mixture provides approximately 50 per cent of the wastewater heating required. In the process, approximately 55 per cent of the product water is produced by the condensing water vapor in the column. This water is designated "column condensate". The remainder of the product water is produced from the overheat vapor left in the column that is fed into an air-cooled heat exchanger. The water which condenses in the exchanger is designated "overhead condensate". Both the column and overhead condensates flow into the product condensate tank.

The unvaporized liquid waste at the bottom of the column is discharged to the recirculating feed tank where it is mixed with new wastewater solution. This solution is recirculated to the top of the column for further processing until the desired concentration is reached. A small amount of ground limestone is added to the solution in the feed recirculating tank to aid in precipitating the insoluble aluminum compounds which would otherwise cause rapid scaling of the Thermopure column. Approximately 4 per cent of the feed solution to the column is tapped-off and routed to the settling tank. Here, about 25 per cent of blowdown is removed from the bottom of the settling tank as sludge (approximately 25,000 mg/L phosphate and limestone), and the other 75 per cent is recirculated to the feed tank. The settling tank has a residence time of approximately four hours.

One unique feature of the process is that the streams exit the column at almost as high a temperature, 90 to 93°C (195 to 200°F), as the incoming steam, so that the latent heat can be used a second time for low-temperature process or space heating.

The process operates at atmospheric pressure so that the equipment does not have to be designed to withstand pressure

or vacuum. All-aluminum components were used in the Warrick plant; however, other materials such as steel, stainless steel, copper alloys or titanium can be used. The choice of materials depends primarily on cost and corrosion resistance to the solution being processed.

A low pressure steam generator connected by ducts to four preheat furnace stacks provided steam from waste stack gas heat to operate the unit. However, due to intermittent operation of the preheat furnaces and fuel reduction to them to conserve energy during the test period, some of the tests were conducted using a portable oil-fired steam generator.

Construction of the plant was started during the summer of 1974 and was completed by December, 1974. A pipeline was installed to carry the effluent from the coil preparation lines to the evaporative treatment plant. The plant was checked out during December, 1974 and operation was started January 3, 1975.

SECTION 2

CONCLUSIONS

1. The Thermopure evaporative treatment installation at Warrick demonstrated that it has performance capability and reliability for commercial operation. The plant operated and produced water of excellent quality when effluent feed and steam were available.

2. This installation demonstrated a substantial savings in money and energy by recovering water and chemicals from the wastewater effluent while operating from waste stack gas heat. Projected figures indicate that a net operating credit can be realized.

3. The recovered condensate water is of high purity with an average conductivity around 6 microsiemens/cm. Over 80 per cent of the total effluent wastewater can be recycled for use as rinse water at the coil preparation line.

4. The concentrated phosphate blowdown can be filtered of suspended solids and recycled to the coil preparation line for use as make-up in the phosphate cleaning solution. The filtered solids, consisting mainly of phosphate and limestone, can be used as a fertilizer additive.

5. This process represents a unique system for handling low concentration wastewater effluents from any industrial process where high purity water and/or chemical recovery for recycling is desired, or simply for reducing the total volume of effluent to facilitate waste disposal. The process is particularly economically attractive where waste stack gas heat is available.

SECTION 3

RECOMMENDATIONS

The operation of the Warrick installation should be continued with the necessary modifications. It could serve as a treatment system for the phosphate wastewater effluent and as a demonstration unit. It would be necessary to make several changes in the present system to allow continuous operation with minimum attendance and to recycle condensate water and phosphate concentrate to the coil preparation lines.

The major changes in the Warrick installation would include a steam generating system to provide a constant supply of 1360 kg/hr (3,000 lb/hr) steam. One source could be steam generation from existing high temperature hot water (HTHW), but serious consideration should be given to the use of waste stack gas heat for generating the low pressure steam. For example, the present waste heat generating system could be equipped with an auxiliary burner to permit operation when waste heat is not available. Other recommended improvements in the system would include oil removal equipment to process the wastewater effluent and/or product condensate water, a larger storage tank for the wastewater to provide a more constant supply, and an improved settling tank for removing the phosphate concentrate blowdown. The estimated operating costs and credits for the evaporative process incorporating these changes are given in Table 1.

Although this small pilot plant shows a net operating cost, Section 6 contains cost analyses which indicate that a net operating credit can be realized for larger commercial systems. For this reason, it is recommended that the present installation be expanded to treat the total volume of effluent waste at Warrick. This would include the extension of the column array using the latest technology presently under development at the Alcoa Laboratories. This advance design column should have lower capital cost and considerably lower steam requirements.

Plans will proceed with commercialization of the new evaporative process. Many industries could benefit from this system for treating low concentration wastewater effluent. Much of the heat to run the process can be reused since the condensate and blowdown temperatures are around 90.6^{o}C (195^{o}F). These

streams could be used to heat other process waters or could be used directly for space heating. The evaporative column can be thought of as a heat exchanger which produces high quality water and concentrates waste streams at the same time. Energy conservation and pollution control are two important national goals; the evaporative process offers the advantage of accomplishing both.

TABLE 1 OPERATING DATA FOR THE WARRICK 75,700 L/d (20,000 GPD) EVAPORATIVE PROCESS

	Materials & Labor	Heat Recovery System ($/h)	Boiler System ($/h)
Operating Expenses			
Utilities			
Steam	1270 kg/h (2,800 lb/h)	0.00	5.60
Electricity	15 kw	0.30	0.30
Chemicals:			
Limestone	5.9 kg/h (13 lb/h)	0.033	0.033
Sulfuric Acid	3.7 kg/h (8.2 lb/h)	0.164	0.164
Labor:			
Operating, Lab., R&M	0.5 man	5.00	5.00
		$5.50/h	$11.10/h
Operating Credits			
Material Reuse:			
High Purity Water	2430 L/h (642 gal/h)	(1.61)	(1.61)
Phosphate	6.7 kg/h (13.7 lb/h)	(1.78)*	(1.78)*
		$3.39/h	$3.39/h
Net Operating Cost		$2.11/h	$7.71/h
		$0.71/ 1000 L	$2.60/ 1000 L
		($2.69/ 1000 gal)	($9.84/ 1000 gal)

* At 50% reuse - 3.4 kg/h (6.9 lb/h)

SECTION 4

OPERATIONAL STUDY

FIRST SERIES OF TESTS

The first series of tests were made from January to May, 1975. Since the plant was exposed to the weather and was operated only on weekdays, considerable difficulty was experienced from freeze-ups over the weekend when the plant was shut down. This caused delays to thaw out or repair damaged pipes and meters. The only other cause for operational delays resulted from the lack of effluent feed and steam to the system. The effluent interruptions occurred when the coil preparation lines were inoperative or not producing phosphate waste. Steam interruptions occurred when the preheat furnaces, from which the waste heat was taken, were shut down or not operated at high heat.

Filter screens were present in the effluent inlet line to remove foreign matter such as paper, rags, and other miscellaneous debris. The low concentration phosphate effluent feed had a pH of around 10. To protect the aluminum equipment and to precipitate contaminating aluminum compounds, the effluent was neutralized with sulfuric acid in a 7570 litre (2,000 gallon) tank. Approximately 60 per cent acid by weight of the phosphate content of the effluent was required. The neutralization system and tank operated satisfactorily except for a malfunction of the acid feed pump. Two thousand parts per million ground limestone was added to the effluent at the feed tank to help precipitate the insoluble compounds and prevent rapid scaling of the process tubes. To maintain the freshly added limestone in suspension and still achieve settling of the precipitate from the effluent, a 3785 litre (1,000 gallon) settling tank was installed. The feed make-up could then be stirred properly in the feed recirculating tank and the precipitate allowed to settle in the settling tank. Without this separate tankage, the feed became very thick.

Because the preheat furnaces were operated intermittently, the steam supply to the process was not constant. This made it impossible to operate the column under constant conditions. Also, the steam production was only 60 per cent of the original design capacity of 1450 kilograms per hour (3200 pounds per

hour) at a stack gas temperature of 316°C (600°F). The maximum temperature, around 290°C (555°F), occurred during tests in January, 1975. In February, 1975 the heat input to the preheat furnaces was reduced to conserve fuel. This dropped the maximum temperature for the remainder of the tests to the 204 to 260°C (400 to 500°F) range.

As expected, the product condensate rate from the process plant increased as the stack gas temperature increased. Condensate production, therefore, was limited by the amount of steam produced. The maximum steam production from the stack gas steam generator was only 907 kg/hr (2000 lbs/hr). The average condensate production rate ranged from approximately 45,400 L/day (12,000 gpd) for stack temperatures around 260 to 288°C (500 to 555°F) to 22,700 L/day (6000 gpd) for temperatures around 177 to 204°C (350 to 400°F). See Table 2. The effluent feed was concentrated to a maximum of 34,000 mg/L total dissolved solids. Analyses of the various streams are given in Table 3.

TABLE 2. WASTE HEAT STEAM GENERATION*

Stack Gas Temperature (°C)	Average Condensate Rate (L/d)
260 to 291 (500 to 555°F)	45,042 (11,900 gpd)
232 to 260 (450 to 500°F)	31,037 (8,200 gpd)
204 to 232 (400 to 450°F)	26,874 (7,100 gpd)
177 to 204 (350 to 400°F)	21,575 (5,700 gpd)

* First series of tests (January 3 to May 7, 1975).

The level of total dissolved solids and phosphate was satisfactory during the periods of normal operation. Occasionally the feed had a tendency to foam, particularly during start-up. During these periods the amount of entrainment in the condensate increased. Most of the oil was carried over as oil vapor so that oil contamination was unavoidable. Various mechanical and adsorption systems can be used to remove the small quantity of oil from the condensate if required. Samples of the condensate and phosphate concentrate for reuse were evaluated at the Alcoa Laboratories; they will be discussed later.

The most serious problem encountered in operation of the column was plugging of some of the tubes. After about three months' operation, the column was opened for inspection. About 25 per cent of the tubes in the center of the tube bundle were totally or partially plugged by scale buildup, while the remaining tubes in the outer 75 per cent of the tube bundle were in good condition and showed only a very thin scale. A slow formation of scale was expected, based on laboratory tests, and this could be removed in about one hour by cold 5 per cent phosphoric acid. Provisions were made for circulating this acid for cleaning purposes. It readily removed the scale from the outer tubes, but the plugged inner tubes had to be mechanically cleaned (drilled).

SECOND SERIES OF TESTS

A second series of tests were scheduled for June 2 to July 10, 1975 using a portable oil-fired boiler to provide a constant supply of steam. The objectives of these tests were to operate the plant under steady state conditions, investigate the tube plugging problem and to supply condensate water and phosphate concentrate for laboratory tests in a pilot coil cleaning line to determine their suitability for reuse.

Prior to initiating this second test series, it was thought that tube plugging occurred when the feed solution had formed a thick mass before proper stirring and settling was obtained. This theory was disproved when the previously cleaned column was opened for inspection after only three days into this new test period. About 10 per cent of the tubes in the center of the bundle were again plugged while the remaining tubes were clean. The aluminum column top was replaced with a transparent plastic cover so that the top of the tube bundle could be observed during operation. Once this was done, the reason for the plugging of the center tubes became evident. The feed water was sprayed onto the tube sheet by a single nozzle, which gave a poor spray distribution pattern. Most of the spray went to the outside tubes while the center tubes received very little spray. The average feed water rate per tube was 0.57 L/min (0.15 gpm) and the evaporation rate was about 0.08 L/min (0.02 gpm) per tube. If the flow rate through a tube were lower than the evaporation rate, the feed solution would dry out on the inside surface of the tube rapidly building up scale until the tube was plugged with deposit.

Through this second series of tests the condensate rate averaged 47,300 L/day (12,500 gal/day) ranging from 36,700 to 60,200 L/day (9700 to 15,100 gal/day). The volume of effluent treated averaged 56,000 L/day (14,800 gal/day) ranging from 45,800 to 71,200 L/day (12,100 to 18,800 gal/day) and the average steam rate was 910 kg/hr (2000 lb/hr) ranging

from 730 to 1100 kg/hr (1600 to 2400 lb/hr). Compositional data given in Table 4 were satisfactory except for the high level of dissolved solids in the column condensate. Examination of the data obtained during the first series of tests showed that excellent quality condensate had been obtained during this period, but that the quality started to deteriorate during the latter weeks of those tests and continued to deteriorate during these tests in June. This behavior suggested that the demister may have been partially plugged so that it could no longer function properly. The demister was removed for examination, and it was found that more than half of the free space was plugged so that the vapor velocity through the remaining space was too high and entrainment into the column condensate results. The demister was cleaned by immersion in cold 5 per cent phosphoric acid so that it would be clean for the next series of tests. A multiple-nozzle spray system was designed to improve the uniformity of the spray over the tubes and installed for the next series of tests conducted during the month of September. The results of the laboratory tests to determine whether the condensate water and phosphate concentrate could be reused will be discussed later.

THIRD SERIES OF TESTS

The objectives of this third series of tests conducted from September 3 to October 3, 1975 were to determine the effectiveness of the multiple spray nozzles in preventing plugging of the center tubes, confirm the deterioration of the column condensate quality if the demister should become plugged, investigate two systems to reduce the oil content in the product water condensate, and demonstrate the reliability of the evaporative plant by continuous operation from Monday to Friday for a one month period.

The results obtained with the multiple spray nozzles were encouraging. Portholes were installed so that the spray action could be seen. Observation of the spray pattern confirmed that the desired uniformity had been achieved. After the first week of operation, the column was opened for inspection. No scale was evident from visual inspection; a rod dropped through the tubes confirmed that they were open. The column was operated for another week, and the inspection again showed that the tubes were open; however, a thin layer of scale was removed by cleaning with cold 5 per cent phosphoric acid for one hour. The same pattern was observed during the last two weeks of this test series.

The demister was left out of the system during the first week of operation to get a measure of the demister effectiveness. As expected, the column condensate quality was poor with the TDS (total dissolved solids) varying from 10 to 200 mg/L and

averaging 85 mg/L. However, the overhead condensate quality was good, varying from 0 to 22 mg/L. The clean demister was then put back in the vapor bypass line and the column condensate quality improved dramatically. The TDS of the column condensate varied from 0 to 10 mg/L and averaged 4.2 mg/L, and the overhead condensate varied from 0 to 10 mg/L and averaged 4.4 mg/L. These results clearly demonstrated the effectiveness of the demister and the necessity of keeping it clean. It could be cleaned in place at the same time the tube bundle is cleaned.

Although laboratory tests conducted with product water condensate from the second series of tests had shown that a small quantity of oil in the water is not detrimental when used as rinse water, it was felt desirable to study some methods of lowering the oil content. This might be necessary if the condensate were to be used for other purposes. The column and overhead condensate streams were combined in the condensate tank. Two types of oil removal equipment were tested. One was a mechanical oil separator, and the other system was a 20.3 cm (8 inch) diameter carbon adsorption column packed to a depth of 107 cm (3-1/2 feet) with 30 mesh activated carbon. Condensate was passed through the mechanical oil separator at a rate of 28.4 L/min (7.5 gpm) and through the carbon column at 3.8 L/min (1.0 gpm). The average oil content of inlet condensate was 19 mg/L. After passing through the mechanical oil separator, the average oil content was 15 mg/L; and after the carbon column, the average oil content was 10 mg/L. By conducting further studies with the oil separators, it is felt that these results can be improved. A summary listing of the overall results of this third series of tests is contained in Table 5.

The reliability of the evaporative process during this series was demonstrated by the fact that the plant operated satisfactorily as long as effluent and steam were supplied. The system operated satisfactorily about 80 per cent of the time between startup at the beginning of the week and shutdown at the end of the week. The 20 per cent downtime was caused either by failures of the portable boiler or by an insufficient volume of effluent for processing.

SECTION 5

WATER AND PHOSPHATE RECYCLING

Product water and phosphate concentrate were evaluated at Alcoa Laboratories to determine whether they could be recycled to the coil cleaning lines. The condensate would be used for rinsing purposes and the phosphate would be used for make-up to the chemical cleaning solution. The oil content and conductivity of the condensate sample returned from the first series of tests are listed in Table 6. They represented a wide range of values and were evaluated to determine their suitability for use as rinse water in place of the deionized water presently used. The tests indicated that the process condensate was satisfactory for use as rinse water. The slight oil and dissolved solids did not affect the finishing quality of aluminum.

A sample of the phosphate concentrate also taken during the first test series (March 20, 1975) was tested to determine if it could be used to make up fresh phosphate cleaning solution. A portion of this sample was processed by ultra-filtration using a polysulfone (PM10) membrane with 38Å pore size. Another portion was settled and decanted, and a third portion was passed through an activated carbon column after settling and decanting. The pH of the three solutions was adjusted to between 10 and 11 with sodium hydroxide to produce the desired etching activity on aluminum. The results of the etching tests are given in Table 7. All three solutions gave the desired etching activity required of the cleaning solution.

As a final test, all three of the previously mentioned phosphate solutions were combined and evaluated as a cleaning solution on the Laboratories' pilot coil preparation line. Evaluated were the evaporative process phosphate concentrate, a 1:1 mixture of this solution and fresh phosphate cleaning solution, and 100 per cent fresh solution as a control. The results showed that the column phosphate concentrate and the 1:1 mixture was comparable to fresh solution and gave acceptable cleaning at contact times usually encountered in plant coil cleaning lines.

On June 10, 11, 12, and 13, during the second series of tests, 1136 litres (300 gallons) of phosphate concentrate and

1136 litres (300 gallons) of column and overhead condensate were collected and sent to the laboratory for more extensive tests at the pilot coil preparation line. Table 8 gives the analysis of the phosphate concentrate. The results showed that the phosphate concentrate would be reusable at the cleaning stage of the coil preparation lines for processing rigid container sheet. Approximately 50 to 60 per cent fresh phosphate cleaning solution had to be added to the phosphate concentrate to achieve satisfactory cleaning efficiency. The condensate water was also shown to be reusable as rinse water in the coil preparation lines.

SECTION 6

ECONOMIC EVALUATION

When the data from the operations of the 75,700 L/d (20,000 gpd) evaporative process at Warrick are translated to a commercial size system, a very favorable economic situation exists. In fact, a net operating credit can be realized. Table 9 contains a cost evaluation for a system based on the total dilute wastewater effluent at Warrick of 1,100,000 L/d (300,000 gpd). Capital operating costs are given for a system operating from waste heat and employing an oil-fired boiler. The cost bases for this analysis are:

1.	Phosphate concentration in effluent	2100 mg/L
2.	Reduced volume of effluent	5.5X
3.	Per cent phosphate recovered	50
4.	Steam	$4.41/1000 kg ($2.00/1000 lb)
5.	Electricity	$5.56/GJ ($0.02/KWH)
6.	Deionized water	$0.66/1000 L ($2.50/1000 gal)
7.	Ground limestone	$5.51/metric ton $5.00/ton
8.	Sulfuric acid	$0.04/kg ($0.02/ lb)
9.	Phosphate	$0.57/kg ($0.26/ lb)
10.	Phosphoric acid	$0.04/kg (0.02/ lb)
11.	Labor	$10.00/man-h
12.	Operates 24 hr/day, 365 days/hr	

In terms of capital investment, the heat recovery system added an additional $240,000 cost. However, the savings in energy reduce the daily operating costs from $2,759 to $651. Where credit is taken for the high purity water and phosphate recovery, the net operating cost of the system employing a boiler is $1.24/1000 L ($4.70/1000 gal). A credit of $0.62/1000 L ($2.33/1000 gal) is realized by utilizing waste heat.

An advanced system design has been tested in the laboratory which reduces the energy consumption by approximately 40%. Since the steam cost is major in the system employing a boiler, the net operating cost is reduced by more than 50 per cent using the more efficient design. This makes the evaporative system very attractive economically, even when waste heat is not used.

TABLE 3. SUMMARY OF STREAM ANALYSES* - FIRST SERIES OF TESTS (JANUARY 3 TO MAY 7, 1975)

Stream		Flow Rate (L/d)	pH	Total Dissolved Solids @ 500°C (mg/L)	Total P as PO_4 (mg/L)	Oil (mg/L)
Waste Effluent	Range	17 411 - 77 971 (4600 - 20 600 gpd)	9.6 - 10.6	1600 - 18 200	480 - 10 900	27 - 800
	Average	35 579 (9400 gpd)	10.0	4800	2600	220
Feed Make-Up	Range	----	5.6 - 9.9	----	600 - 11 700	40 - 370
	Average	----	6.7	----	2900	170
Condensate						
Normal Operation						
Column	Range	----	----	0 - 57	0.5 - 5.5	----
	Average	----	----	12	2.5	----
Overhead	Range	----	----	0 - 16	0.4 - 4.2	----
	Average	----	----	5	2.0	----
Overall Operation						
Column	Range	4542 - 29 145 (1200 - 7700 gpd)	5.0 - 7.6	0 - 348	0.6 - 62	0 - 20
	Average	14 762 (3900 gpd)	6.4	48	11.7	9
Overhead	Range	6052 - 22 710 (1600 - 6000 gpd)	4.9 - 7.1	0 - 62	0.4 - 11.7	9 - 81
	Average	12 112 (3200 gpd)	5.7	8	2.7	44
Process Blowdown	Range	757 - 22 332 (200 - 5900 gpd)	6.0 - 8.5	3800 - 34 000	----	190 - 1670
	Average	9084 (2400 gpd)	6.9	14 000	----	610
Steam	Range	345 - 907 kg/hr (760 - 2000 lb/hr)	----	----	----	----
	Average	726 kg/hr (1600 lb/hr)	----	----	----	----

*Values were taken from the laboratory stream analyses except for the TDS (total dissolved solids) and flow rate data. TDS were determined from conductivity measurements and calibration curves derived from laboratory results. Extreme values were generally ignored.

TABLE 4. SUMMARY OF STREAM ANALYSES* - SECOND SERIES OF TESTS (JUNE 2 TO JULY 10, 1975)

Stream		Flow Rate (L/d)	pH	Total Dissolved Solids @ 500°C (mg/L)	Total P as PO_4 (mg/L)	Oil (mg/L)
Waste Effluent	Range	45 799 - 71 158 (12 100 - 18 800 gpd)	9.1 - 10.3	1000 - 11 800	480 - 8100	96 - 320
	Average	56 018 (14 800 gpd)	10.0	4700	2100	190
Feed Make-Up	Range	----	6.1 - 7.2	----	480 - 7500	56 - 220
	Average	----	6.6	----	2700	120
Condensate						
Column	Range	27 252 - 36 336 (7200 - 9600 gpd)	5.8 - 8.2	20 - 320	19 - 60	3 - 15
	Average	31 794 (8400 gpd)	7.1	140	33	9
Overhead	Range	9463 - 20 818 (2500 - 5500 gpd)	4.9 - 6.5	0 - 18	0.0 - 3.1	11 - 87
	Average	15 519 (4100 gpd)	5.4	9.5	1.1	36
Process Blowdown	Range	1779 - 28 009 (470 - 7400 gpd)	5.3 - 8.6	3500 - 44 000	5800 - 40 000	250 - 1300
	Average	8706 (2300 gpd)	7.2	27 500	17 300	670
Steam	Range	726 - 1089 kg/hr (1600 - 2400 lb/hr)	----	----	----	----
	Average	907 kg/hr (2000 lb/hr)	----	----	----	----

*Values were taken from the laboratory stream analyses except for the TDS (total dissolved solids) and flow rate data. TDS were determined from conductivity measurements and calibration curves derived from laboratory results. Extreme values were generally ignored.

TABLE 5. SUMMARY OF STREAM ANALYSES* - THIRD SERIES OF TESTS (SEPTEMBER 3 TO OCTOBER 3, 1975)

Stream		Flow Rate (L/d)	pH	Total Dissolved Solids @ 500°C (mg/L)	Total P as PO_4 (mg/L)	Oil (mg/L)
Waste Effluent	Range	53 747 - 83 649 (14 200 - 22 100 gpd)	9.7 - 10.6	2000 - 8000	500 - 9900	70 - 240
	Average	71 158 (18 800 gpd)	10.1	4700	3400	160
Feed Make-Up	Range	----	4.1 - 9.6	----	710 - 10 400	70 - 560
	Average	----	6.5	----	3300	220
Condensate Without Demister Column	Range	----	5.1 - 7.9	10 - 200	58 - 110	6 - 29
	Average	----	6.6	85	81	12
Overhead	Range	----	5.2 - 6.0	0 - 22	0.6 - 2.3	10 - 50
	Average	----	5.6	7.5	1.3	27
With Demister Column	Range	----	5.1 - 7.9	0 - 10	1.3 - 6.4	6 - 29
	Average	----	6.6	4.2	3.9	12
Overhead	Range	----	5.2 - 6.0	0 - 10	0.6 - 2.5	10 - 50
	Average	----	5.6	4.4	1.4	27
Combined Condensate	Range	46 934 - 64 345 (12 400 - 17 000 gpd)	4.2 - 6.9	----	0.5 - 4.3	8 - 30
	Average	58 289 (15 400 gpd)	5.6	----	1.6	19
Mechanical Oil Separator	Range	----	----	----	----	5 - 25
	Average	----	----	----	----	15
Carbon Adsorption of Oil	Range	----	----	----	----	1 - 23
	Average	----	----	----	----	10
Process Blowdown	Range	3785 - 25 360 (1000 - 6700 gpd)	6.1 - 8.7	17 600 - 36 100	5100 - 25 100	39 - 5600
	Average	12 869 (3400 gpd)	6.8	26 800	13 800	910
Steam	Range	1043 - 1724 kg/hr (2300 - 3800 lb/hr)	----	----	----	----
	Average	1270 kg/hr (2800 lb/hr)	----	----	----	----

*Values were taken from the laboratory stream analyses except for the TDS (total dissolved solids) and flow rate data. TDS were determined from conductivity measurements and calibration curves derived from laboratory results. Extreme values were generally ignored.

TABLE 6. ANALYSES OF CONDENSATE SAMPLES

Sample Number	Conductivity Microsiemens/cm	Oil mg/L
1	4	8.7
2	4	5.4*
3	24	80
4	24	0.2*
5	9	0.7
6	9	0.0*
7	25	135
8	95	8.2
9	3	4.8
10	16	52.7

*Processed in laboratory carbon adsorption column.

TABLE 7. ANALYSES OF PHOSPHATE CLEANING SOLUTION

	Concentrated Phosphate		
	Ultra-Filtered	Settled	Settled and Adsorbed on Carbon
pH	10.55	10.55	10.55
Oil (mg/L)	----	254	4
Aluminum (mg/L)	90	370	440
*Etch Activity (mg/m^2)	213	207	258
Reaction Products	None	None	None

* Acceptable etch activity is 215-269 mg/m^2 for the 30 second test.

TABLE 8. ANALYSIS OF PHOSPHATE CONCENTRATE

Items	Concentration (mg/L)
Total Solids	21,800
Total Dissolved Solids	20,500
Ortho Phosphate	0
Total P as PO_4	9,600
SO_4	6,700
Al	490
Oil	254

TABLE 9 COST EVALUATION FOR A 1,100,000 L/d (300,000 GPD) EVAPORATIVE PROCESS PLANT

	Materials & Labor	Heat Recovery System	Boiler System
Capital Costs ($1,000)			
Thermopure		$810	$810
Steam System		383	142
pH Control		35	35
Wastewater Pretreatment		120	120
Blowdown Treatment		118	118
Chemical Cleaning System		33	33
		$1499	$1258
Operating Expenses ($/day)			
Utilities:			
Steam	20,230 kg/h (44,600 lb/h	0	2141
Electricity	240 kw	115	115
Chemicals:			
Limestone	94 kg/h (207 lb/h)	12	12
Sulfuric Acid	59 kg/h (131 lb/h)	63	63
Phosphoric Clean. Acid	1.6 kg/h (3.4 lb/h)	16	16
Labor:			
Operating, Lab., R&M	1 man	240	240
Depreciation (5%/yr)		205	172
		$651/ day	$2759/ day
Operating Credits ($/day)			
Material Reuse:			
High Purity Water	38,800 L/h (10,240 gal/h)	614	614
Phosphate	50% of 107 kg/h (236 lb/h)	736	736
		$1350/ day	$1350/ day
Net Operating Cost/Credit			
	($/day)	$699(Cr.)	$1409
	($/1000 L)	0.62(Cr.)	1.24
	($/1000 gal)	2.33(Cr.)	4.70

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APPENDIX WARRICK PILOT PLANT DATA FROM THREE SERIES OF TESTS

TABLE A-1. WARRICK PILOT PLANT DATA - FIRST SERIES OF TESTS (JANUARY 3 TO MAY 7, 1975)

DATA		DATE 1/3	1/6	1/11	1/21	1/22
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		-----	-----	-----	61 923 (16 360)	-----
Total Dissolved Solids - mg/L		17 000	-----	10 200	6 846	18 200
P as PO_4 - mg/L		-----	-----	-----	11 700	-----
PROCESS BLOWDOWN						
Temperature - ^{o}C (^{o}F)		88 (191)	88 (191)	87 (189)	91 (195)	81 (177)
pH		-----	-----	-----	6.1	-----
Total Dissolved Solids - mg/L		17 250	15 200	10 720	23 400	20 167
P as PO_4 - mg/L		-----	-----	-----	16 000	-----
Volume - L/Day (gpd)		-----	-----	-----	16 351 (4320)	-----
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	3.7	-----	2.65	36	-----
	Overhead	3.7	-----	3.7	0	-----
P as PO_4 - mg/L	Column	-----	-----	-----	5.1	-----
	Overhead	-----	-----	-----	3.6	-----
Volume - L/Day (gpd)	Column	27 782 (7340)	27 479 (7 260)	29 046 (7 674)	22 861 (6 040)	18 353 (4849)
	Overhead	8 251 (2180)	19 531 (5 160)	13 702 (3 620)	22 710 (6 000)	13 853 (3660)
	Total	36 033 (9520)	47 010 (12 420)	42 748 (11 294)	45 571 (12 040)	32 206 (8509)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^{o}C (^{o}F)		236 (457)	264 (508)	291 (555)	284 (543)	223 (434)
Stack Gas Out - ^{o}C (^{o}F)		118 (245)	119 (247)	114 (238)	113 (236)	102 (216)
Steam Use - kg/d (Lbs/Day)		3421 (7542)	20 722 (45 685)	20 987 (46 269)	18 498 (40 782)	19 769 (43 584)
ACTUAL OPERATING TIME						
Hrs/Day		4	5	10	4	11

(continued)

TABLE A-1. (continued)

DATA		DATE 1/23	1/24	1/28	1/29	1/30
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		36 654 (9684)	39 871 (10 534)	45 140 (11 926)	23 948 (6327)	32 048 (8467)
Total Dissolved Solids - mg/L		1874	3167	3864	4466	4786
P as PO_4 - mg/L		600	-----	-----	2920	-----
PROCESS BLOWDOWN						
Temperature - ^oC (^oF)		80 (176	79 (174)	81 (178)	77 (171)	77 (170)
pH		6.5	-----	-----	6.5	-----
Total Dissolved Solids - mg/L		20 000	17 000	12 471	34 070	17 125
P as PO_4 - mg/L		6260	-----	-----	16 000	-----
Volume - L/Day (gpd)		3406 (900)	8138 (2150)	17 260 (4560)	742 (196)	12 718 (3360)
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	348	-----	8.35	20	6.3
	Overhead	10	-----	9.5	12	3.2
P as PO_4 - mg/L	Column	170	-----	-----	40	-----
	Overhead	4.2	-----	-----	2.9	-----
Volume - L/Day (gpd)	Column	17 615 (4654)	16 306 (4303)	15 163 (4006)	12 532 (3311)	9 073 (2397)
	Overhead	15 632 (4130)	15 632 (4130)	12 718 (3360)	10 674 (2820)	10 257 (2710)
	Total	33 247 (8784)	31 938 (8438)	27 881 (7366)	23 206 (6131)	19 330 (5107)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^oC (^oF)		251 (483)	249 (480)	227 (440)	209 (408)	196 (385)
Stack Gas Out - ^oC (^oF)		107 (225)	105 (221)	107 (225)	107 (224)	104 (220)
Steam Use - kg/d (Lbs/Day)		21 338 (47 043)	20 273 (44 695)	16 930 (37 324)	14 128 (31 146)	10 604 (23 378)
ACTUAL OPERATING TIME						
Hrs/Day		19	7	20	20	20

(continued)

TABLE A-1. (continued)

DATA		DATE 1/31	2/13	2/17	2/18	2/19
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		40 870 (10 798)	24 708 (6528)	29 478 (7788)	34 761 (9184)	30 541 (8069)
Total Dissolved Solids - mg/L		4380	1633	3340	3500	3150
P as PO_4 - mg/L		2340	-----	3400	-----	2000
PROCESS BLOWDOWN						
Temperature - ^oC (^oF)		78 (172)	81 (177)	76 (169)	80 (176)	78 (172)
pH		6.9	-----	6.8	-----	7.4
Total Dissolved Solids - mg/L		11 564	3833	9990	13 583	13 302
P as PO_4 - mg/L		4900	-----	8900	-----	6400
Volume - L/Day (gpd)		17 297 (4570)	-----	-----	7949 (2100)	7343 (1940)
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	24	70	2	4.1	2
	Overhead	20	30	4	3.3	8
P as PO_4 - mg/L	Column	2.6	-----	1.1	-----	2
	Overhead	1.8	-----	0.9	-----	12
Volume - L/Day (gpd)	Column	12 407 (3278)	8743 (2310)	11 771 (3110)	12 354 (3264)	10 481 (2769)
	Overhead	11 166 (2950)	-----	-----	14 459 (3820)	12 718 (3660)
	Total	23 573 (6228)	-----	-----	26 813 (7084)	23 199 (6129)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^oC (^oF)		18 (369)	224 (435)	211 (411)	247 (477)	246 (474)
Stack Gas Out - ^oC (^oF)		97 (207)	103 (218)	101 (213)	109 (228)	109 (228)
Steam Use - kg/d (Lbs/Day)		14 555 (32 088)	-----	-----	21 341 (47 049)	19 303 (42 555)
ACTUAL OPERATING TIME						
Hrs/Day		6	4	10	16	15

(continued)

TABLE A-1. (continued)

DATA		DATE 2/20	2/24	2/25	2/26	2/27
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		17 237 (4554)	77 880 (20 576)	36 896 (9748)	39 232 (10 365)	24 375 (6440)
Total Dissolved Solids - mg/L		2900	6380	5275	5038	4967
P as PO_4 - mg/L		-----	-----	-----	-----	-----
PROCESS BLOWDOWN						
Temperature - ^oC (^oF)		76 (169)	74 (165)	78 (173)	76 (169)	76 (169)
pH		-----	6.7	-----	-----	-----
Total Dissolved Solids - mg/L		15 670	9800	12 667	10 325	15 389
P as PO_4 - mg/L		-----	7300	-----	-----	-----
Volume - L/Day (gpd)		2612 (690)	52 990 (14 000)	14 497 (3830)	19 985 (5280)	6624 (1750)
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	3.5	0	2.5	2.4	2.2
	Overhead	2	0	2.3	2.9	2.8
P as PO_4 - mg/L	Column	-----	1.3	-----	-----	-----
	Overhead	-----	0.8	-----	-----	-----
Volume - L/Day (gpd)	Column	7 116 (1180)	10 734 (2836)	13 013 (3438)	10 011 (2645)	8 630 (2280)
	Overhead	10 144 (2680)	14 156 (3740)	9 387 (2480)	9 235 (2440)	9 122 (2410)
	Total	17 260 (3860)	24 890 (6576)	22 400 (5918)	19 246 (5085)	17 752 (4690)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^oC (^oF)		257 (495)	267 (512)	253 (488)	267 (512)	261 (501)
Stack Gas Out - ^oC (^oF)		129 (233)	118 (245)	117 (243)	119 (247)	117 (242)
Steam Use - kg/d (Lbs/Day)		17 919 (39 504)	20 575 (45 360)	16 863 (37 176)	22 173 (48 884)	18 250 (40 235)
ACTUAL OPERATING TIME						
Hrs/Day		7	8	9	14	22

(continued)

TABLE A-1. (continued)

DATA		DATE 2/28	3/3	3/4	3/5	3/6
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		21 650 (5720)	21 029 (5556)	18 490 (4885)	62 831 (16 600)	38 948 (10 290)
Total Dissolved Solids - mg/L		3033	4520	3720	4650	3340
P as PO_4 - mg/L		-----	-----	4600	-----	2200
PROCESS BLOWDOWN						
Temperature - ^{o}C (^{o}F)		76 (169)	73 (163)	71 (160)	73 (164)	76 (168)
pH		6.4	-----	7.1	7.9	7.5
Total Dissolved Solids - mg/L		13 333	9500	19 200	9010	8600
P as PO_4 - mg/L		5100	-----	9300	9100	5200
Volume - L/Day (gpd)		5526 (1460)	3429 (906)	1684 (445)	36 715 (9700)	15 254 (4030)
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	16	3.5	16	0	18
	Overhead	2	2.5	0	0	2
P as PO_4 - mg/L	Column	3.7	-----	0.6	-----	0.8
	Overhead	2.6	-----	1.1	2.3	1.0
Volume - L/Day (gpd)	Column	10 068 (2660)	-----	-----	-----	-----
	Overhead	6 056 (1600)	-----	-----	-----	-----
	Total	16 124 (4260)	17 600 (4650)	16 805 (4440)	26 117 (6900)	25 057 (6620)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^{o}C (^{o}F)		263 (505)	233 (451)	221 (430)	245 (473)	253 (488)
Stack Gas Out - ^{o}C (^{o}F)		118 (245)	110 (231)	108 (226)	113 (235)	111 (232)
Steam Use - kg/d (Lbs/Day)		17 282 (38 100)	-----	-----	16 828 (37 100)	16 375 (36 100)
ACTUAL OPERATING TIME						
Hrs/Day		3	4	6	3	3

(continued)

TABLE A-1. (continued)

DATA		DATE 3/10	3/11	3/12	3/13	3/14
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		54 031 (14 275)	40 045 (10 580)	33 857 (8945)	37 699 (9960)	26 862 (7097)
Total Dissolved Solids - mg/L		5900	2900	4833	3810	3080
P as PO_4 - mg/L		-----	600	-----	1600	3400
PROCESS BLOWDOWN						
Temperature - ^{o}C (^{o}F)		81 (178)	78 (172)	77 (171)	73 (164)	78 (173)
pH		6.5	6.8	7.9	8.5	6.5
Total Dissolved Solids - mg/L		7900	12 610	21 300	16 700	17 600
P as PO_4 - mg/L		2100	2900	7800	10 500	5200
Volume - L/Day (gpd)		22 237 (5875)	7835 (2070)	5852 (1546)	9690 (2560)	4534 (1198)
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	70*	0	4	52*	142*
	Overhead	4	0	6	12	61.6
P as PO_4 - mg/L	Column	0.7	1.6	1.1	25	0
	Overhead	1.0	1.6	0.8	1.5	3.7
Volume - L/Day (gpd)	Column	19 186 (5069)	18 092 (4780)	13 168 (3479)	15 519 (4100)	12 755 (3370)
	Overhead	12 608 (3331)	14 118 (3730)	14 837 (3920)	12 188 (3220)	9 538 (2520)
	Total	31 794 (8400)	33 210 (8510)	28 005 (7399)	27 707 (7320)	22 293 (5890)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^{o}C (^{o}F)		119 (400)	232 (450)	233 (452)	226 (438)	207 (405)
Stack Gas Out - ^{o}C (^{o}F)		119 (247)	121 (249)	123 (253)	121 (250)	121 (250)
Steam Use - kg/d (Lbs/Day)		18 225 (40 180)	22 191 (48 922)	18 626 (41 064)	18 824 (41 500)	18 594 (40 992)
ACTUAL OPERATING TIME						
Hrs/Day		1	6	6	4	1

*Foaming Occurred

(continued)

TABLE A-1. (continued)

DATA		DATE 3/18	3/19	3/22	3/27	4/23
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		37 445 (9893)	33 815 (8934)	34 841 (9205)	35 624 (9412)	21 730 (5741)
Total Dissolved Solids - mg/L		9893	8934	9205	9412	5741
P as PO_4 - mg/L		3650	5950	2900	1900	3950
PROCESS BLOWDOWN						
Temperature - ^oC (^oF)		84 (183)	74 (166)	87 (188)	84 (184)	77 (170)
pH		6.2	6.4	6.6	6.8	6.0
Total Dissolved Solids - mg/L		15 350	16 450	6700	9200	15 250
P as PO_4 - mg/L		7250	850	3200	-----	-----
Volume - L/Day (gpd)		5371 (1419)	11 980 (3165)	6298 (1664)	6329 (1672)	4164 (1100)
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	16	7	24	115	99
	Overhead	2.8	5	4	10	29
P as PO_4 - mg/L	Column	2.7	4.8	5.5	-----	-----
	Overhead	2.8	3.1	0.4	-----	-----
Volume - L/Day (gpd)	Column	17 320 (4576)	12 948 (3421)	15 833 (4183)	18 660 (4930)	9 777 (2583)
	Overhead	14 754 (3898)	8 887 (2348)	12 710 (3358)	10 636 (2810)	7 793 (2058)
	Total	32 074 (8474)	21 835 (5769)	28 543 (7541)	29 296 (7740)	17 570 (4641)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^oC (^oF)		249 (481)	227 (440)	229 (445)	213 (415)	224 (436)
Stack Gas Out - ^oC (^oF)		126 (258)	113 (236)	127 (261)	114 (237)	112 (233)
Steam Use - kg/d (Lbs/Day)		19 947 (43 976)	17 136 (37 779)	15 381 (33 910)	15 688 (34 586)	8669 (19 112)
ACTUAL OPERATING TIME						
Hrs/Day		3	5	8	5	5

(continued)

TABLE A-1. (continued)

DATA		DATE 4/24	5/6	5/7
RAW CCL WASTE				
Volume Treated - L/Day (gpd)		22 930 (6058)	36 294 (9589)	35 912 (9486)
Total Dissolved Solids - mg/L		3730	1750	2000
P as PO_4 - mg/L		-----	-----	-----
PROCESS BLOWDOWN				
Temperature - °C (°F)		80 (176)	84 (184)	82 (179)
pH		7.2	6.5	6.6
Total Dissolved Solids - mg/L		14 800	6400	7000
P as PO_4 - mg/L		-----	-----	-----
Volume - L/Day (gpd)		5893 (1557)	6139 (1622)	9932 (2624)
PRODUCT WATER				
Total Dissolved Solids - mg/L	Column	57	275	212
	Overhead	3.0	12	15.5
P as PO_4 - mg/L	Column	-----	-----	-----
	Overhead	-----	-----	-----
Volume - L/Day (gpd)	Column	9 455 (2498)	18 384 (4857)+	14 307 (3780)
	Overhead	7 203 (1903)	11 771 (3110)	11 665 (3082)
	Total	16 658 (4501)	30 155 (7967)	25 972 (6862)
HEAT RECOVERY SYSTEM				
Stack Gas In - °C (°F)		240 (464)	201 (393)	209 (408)
Stack Gas Out - °C (°F)		116 (241)	112 (233)	109 (229)
Steam Use - kg/d (Lbs/Day)		8 299 (18 296)	14 418 (31 787)	11 698 (25 790)
ACTUAL OPERATING TIME				
Hrs/Day		3	2	2

+ Cleaned heat recovery coil (5/5/75)

TABLE A-2. RAW WASTE ANALYSES - FIRST SERIES OF TESTS (JANUARY 3 TO MAY 7, 1975)

Date	pH	Conductivity (µS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
1/21	10.6	9 400	21	12	13 594	11 200	545	10 900	8 760
1/23	10.1	2 680	3	0	2 660	2 286	105	480	360
2/17A	9.8	2 050	82	50	2 220	1 870	305	2 500	1 300
2/17B	9.8	2 100	39	1	6 390	5 840	123	2 400	1 400
2/17C	9.9	3 100	--	--	--	--	118	3 600	2 600
2/17D	9.7	2 800	231	67	3 580	2 740	173	2 600	1 600
2/19A	9.9	2 450	73	21	3 150	2 450	168	1 800	1 500
2/19B	10.6	13 900	157	58	23 600	18 900	800	8 100	6 700
2/19C	9.7	1 940	42	0	2 390	1 870	80	1 100	800
2/24A	9.8	2 500	264	40	3 260	2 640	405	1 500	1 100
2/24B	6.9	3 600	174	70	4 800	4 120	232	2 600	1 000
3/4	10.1	3 300	20	12	4 140	3 300	382	5 200	3 700
3/6	9.9	3 520	13	0	4 640	3 950	180	2 500	2 100
3/7	6.5	3 590	3	0	5 020	4 030	110	1 600	1 100
3/11	10.1	4 450	22	1	6 400	5 000	233	1 400	1 300
3/13	10.0	2 700	7	0	3 440	2 720	151	1 800	1 500
3/14	10.0	2 950	10	0	3 840	3 070	27	1 800	1 500
3/18A	9.6	1 600	6	0	1 900	1 200	87	800	800
3/18B	9.9	2 960	23	6	3 700	3 200	205	1 800	1 400
3/19	9.8	2 520	36	14	3 300	2 700	157	1 500	1 300
3/20	10.0	3 600	43	3	4 800	3 900	181	2 600	2 300
3/26	9.9	2 600	17	0	3 400	2 600	177	800	800
5/7	9.9	3 200	33	8	4 264	3 366	133	1 320	1 100

TABLE A-3. FEED MAKE-UP ANALYSES - FIRST SERIES OF TESTS (JANUARY 3 TO MAY 7, 1975)

Date	pH	Conductivity (µS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
1/21	7.2	11 400	41	19	16 256	6 846	318	11 700	9 100
1/23	7.3	2 040	191	325	2 134	1 874	87	600	400
1/29A	6.2	4 400	95	24	6 256	5 312	40	3 040	2 900
1/29B	6.3	4 050	29	0	5 252	4 466	109	2 920	2 100
1/31	6.0	4 090	18	5	5 082	4 380	47	2 340	1 760
2/17	6.4	2 950	114	66	3 740	3 340	100	3 400	1 900
2/19	6.7	3 050	67	48	3 660	3 150	106	2 000	1 800
3/4	6.7	3 400	20	14	4 260	3 720	367	4 600	3 400
3/6	7.4	3 080	5	3	3 990	3 340	226	2 200	1 500
3/7	9.9	3 090	0	0	3 850	3 230	129	1 700	1 100
3/11	6.8	2 620	30	3	3 420	2 900	176	600	600
3/13	6.5	3 500	19	0	4 480	3 810	117	1 600	1 300
3/14	6.7	2 900	21	1	3 590	3 080	192	3 400	1 100
3/18A	6.3	2 900	17	0	4 000	3 400	102	1 600	1 300
3/18B	6.0	3 400	370	230	4 400	3 900	133	1 600	1 500
3/19A	6.0	4 150	539	399	5 400	4 700	279	2 600	2 400
3/19B	5.6	6 200	35	3	8 000	7 200	279	4 800	4 200
3/20	5.9	4 800	36	10	6 800	6 000	237	3 700	3 400
3/26	6.7	2 700	81	41	3 400	2 900	164	1 500	1 300
5/7	6.6	3 800	318	200	4 830	4 104	180	2 440	2 400

TABLE A-4. COLUMN CONDENSATE ANALYSES - FIRST SERIES OF TESTS (JANUARY 3 TO MAY 7, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
1/21	7.2	12	25	16	66	36	257	5.1	5.1
1/23	7.1	448	11	0	414	348	19	170	164
1/29A	6.6	8 500	13	1	38	22	4	40	3.9
1/29B	5.0	14	12	4	22	20	162	40	6.2
1/31	6.6	5	3	0	30	24	3	2.6	2.1
2/17	6.2	5.1	0	0	10	2	6	1.1	1.1
2/19	5.4	9.5	5	1	2	2	0	2.0	1.8
2/24	5.6	5.2	16	2	6	0	9	1.3	1.1
2/28	5.9	10.1	10	0	24	16	14	3.7	2.6
3/4	6.5	3.1	3	3	18	16	6	0.6	0.6
3/5A	6.4	6.8	5	5	4	4	13	0.6	0.4
3/5B	6.7	6.4	0	0	22	0	3	--	--
3/6	6.1	2.6	0	0	18	18	10	0.8	0.8
3/7	6.1	23.6	0	0	34	34	20	11.3	10.7
3/10	6.4	12.3	0	0	88	70	4	0.7	0.6
3/11	6.4	6.0	0	0	18	0	9	1.6	1.3
3/12	6.5	9.6	0	0	8	4	3	1.1	1.1
3/13	7.6	86.0	0	0	86	52	14	25.0	25.0
3/14	7.0	188	15	11	192	142	18	61.6	60.4
3/18A	6.3	6.0	0	0	22	2	8	1.2	1.1
3/18B	6.0	9.3	0	0	38	30	13	4.2	3.8
3/19A	5.5	16.1	10	0	48	14	9	4.5	4.1
3/19B	6.8	11.2	0	0	32	0	4	5.2	4.0
3/26	6.5	35.0	4	3	42	24	10	5.5	4.9
5/7	6.9	118.0	62	22	156	80	8	49.4	42.8

TABLE A-5. OVERHEAD CONDENSATE ANALYSES - FIRST SERIES OF TESTS (JANUARY 3 TO MAY 7, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
1/21	6.6	22	28	15	10	0	79	3.6	3.6
1/23	7.1	14	28	0	36	10	15	4.2	4.2
1/29	5.5	12	15	1	36	22	17	10.8	10.8
1/29	5.7	12	6	0	6	12	10	2.9	2.9
1/31	5.1	4	4	0	28	20	25	1.8	1.5
2/17	4.9	5.6	0	0	6	4	24	0.7	0.6
2/19	5.1	6.3	3	0	8	8	31	1.2	1.2
2/24	5.3	5.7	25	0	12	0	285	0.8	0.8
2/28	5.9	6.5	27	4	10	2	103	2.6	2.1
3/4	5.7	4.0	5	0	26	0	40	1.1	1.0
3/5A	6.2	6.5	6	5	24	4	73	1.5	1.3
3/5B	5.9	4.9	5	5	10	0	28	2.3	0.8
3/6	5.7	3.5	0	0	24	2	35	1.0	0.8
3/7	5.8	16.7	0	0	20	8	81	11.7	11.2
3/10	5.3	560	0	0	16	4	73	1.0	0.8
3/11	5.9	4.9	0	0	0	0	49	1.6	1.5
3/12	5.7	6.1	0	0	8	6	31	0.8	0.8
3/13	6.3	9.0	0	0	26	12	56	1.5	1.3
3/14	6.1	9.2	4	0	24	0	47	3.7	2.9
3/18A	5.7	7.3	0	0	22	0	60	2.6	2.1
3/18B	5.8	10.8	0	0	34	34	31	3.0	2.8
3/19A	5.6	7.3	0	0	46	2	55	2.3	2.0
3/19B	5.8	8.2	0	0	56	8	9	3.8	3.7
3/26	5.6	4.4	13	2	14	4	474	0.4	0.4
5/7	5.0	8.8	20	0	36	0	308	0.5	0.5

TABLE A-6. PROCESS BLOWDOWN ANALYSES - FIRST SERIES OF TESTS (JANUARY 3 TO MAY 7, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
1/21	6.1	17 200	1 823	1 664	28 610	23 400	269	16 000	14 840
1/23	6.5	14 000	447	270	20 000	17 340	353	6 260	5 140
1/29A	6.5	16 500	978	614	25 900	21 900	861	16 400	11 300
1/29B	6.5	25 000	6 336	5 012	39 080	34 070	711	16 000	13 800
1/31	6.9	9 500	2 826	2 140	3 290	11 564	238	4 900	4 760
2/17	6.8	7 900	194	110	12 500	9 970	676	8 900	5 800
2/19	7.4	9 000	125	91	16 200	13 300	1 310	6 400	5 600
2/24	6.7	13 000	*	*	27 900*	23 800*	1 670	7 300	2 000
2/28	6.4	12 200	*	*	23 800*	20 000*	432	5 100	2 500
3/4	7.1	10 000	*	*	23 400*	19 200*	1 060	9 300	7 300
3/5A	7.7	7 000	*	*	12 700*	10 300*	377	9 800	3 700
3/5B	7.9	6 350	*	*	11 300*	9 010*	296	9 100	2 900
3/6	7.5	6 400	*	*	10 400*	8 600*	279	5 200	4 700
3/7	7.8	5 800	*	*	9 200*	7 660*	186	2 400	2 200
3/10	6.5	5 500	*	*	9 410*	7 980*	187	2 100	2 000
3/11	6.8	8 000	2 050	1 520	14 930	12 610	690	2 900	2 300
3/12	7.9	12 000	*	*	26 900*	21 300*	512	7 800	6 400
3/13	8.5	12 400	*	*	21 400*	16 700*	868	10 500	5 200
3/14	6.5	10 400	*	*	22 100*	17 600*	905	5 200	4 400
3/18A	6.2	8 000	*	*	16 200*	13 600*	361	6 300	5 100
3/18B	6.2	9 400	*	*	20 500*	17 100*	453	8 200	6 400
3/19A	6.4	9 950	164	80	14 500	12 200	633	7 600	5 700
3/19B	6.3	13 100	3 900	3 000	24 400	20 700	934	10 100	7 100
3/20	6.0	15 600	3 900	2 800	25 000	21 200	681	13 800	10 700
3/26	6.6	6 300	2 400	1 700	7 900	6 700	414	3 700	2 900
5/7	6.3	10 600	6 310	4 950	14 600	12 800	520	5 800	4 800

*Sample would not filter - reported as total solids.

TABLE A-7. WARRICK PILOT PLANT DATA - SECOND SERIES OF TESTS (JUNE 2 TO JULY 10, 1975)

DATA		DATE 6/2	6/3	6/4	6/5	6/6
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		53 932 (14 249)	65 223 (17 232)	56 870 (15 025)	50 723 (13 401)	47 914 (12 659)
Total Dissolved Solids - mg/L		1900	1026	2198	2244	2872
P as PO_4 - mg/L		----	400	480	660	2260
PROCESS BLOWDOWN						
Temperature - ^oC (^oF)		93 (200)	94 (202)	94 (201)	94 (201)	94 (201)
pH		6.5	7.35	7.55	7.27	7.75
Total Dissolved Solids - mg/L		8300	11 100	27 300	30 700	26 200
P as PO_4 - mg/L		----	4200	2600	2600	7700
Volume - L/Day (gpd)		9425 (2490)	4164 (1100)	2332 (616)	3183 (841)	5901 (1559)
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	20.0	46.0	108	86.0	90.0
	Overhead	10.4	18.0	5.0	0.0	10.2
P as PO_4 - mg/L	Column	----	19.0	28.5	26.0	25.0
	Overhead	----	0.8	0.7	0.6	0.4
Volume - L/Day (gpd)	Column	34 023 (8 989)	36 306 (9 592)	36 260 (9 580)	29 902 (7 900)	29 145 (7 700)
	Overhead	10 484 (2 770)	20 969 (5 540)	18 282 (4 830)	17 638 (4 660)	12 869 (3 400)
	Total	44 507 (11 759)	57 275 (15 132)	54 542 (14 410)	47 540 (12 560)	42 014 (11 100)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^oC (^oF) *		----	----	----	----	----
Stack Gas Out - ^oC (^oF)*		----	----	----	----	----
Steam Use - kg/d (Lbs/Day)		17 660 (38 934)	23 133 (51 000)	22 906 (50 500)	19 867 (43 800)	----
ACTUAL OPERATING TIME						
Hrs/Day		4	24	7	6	4

* Not measured - portable steam boiler in use.

(continued)

TABLE A-7. (continued)

DATA		DATE 6/10	6/11	6/12	6/13	6/18
RAW CCL WASTE						
Volume Treated - L/Day (gpd)		71 302 (18 838)	52 990 (14 000)	51 798 (13 685)	50 927 (13 455)	45 920 (12 132)
Total Dissolved Solids - mg/L		5600	2612	3144	4400	7500
P as PO_4 - mg/L		----	1120	1506	----	----
PROCESS BLOWDOWN						
Temperature - ^oC (^oF)		95 (203)	94 (202)	92 (197)	93 (199)	94 (202)
pH		7.5	6.5	6.4	6.9	7.9
Total Dissolved Solids - mg/L		15 700	3500	44 000	33 000	42 000
P as PO_4 - mg/L		----	9400	21 000	----	26 000
Volume - L/Day (gpd)		27 964 (7388)	1779 (470)	2971 (785)	3463 (915)	7388 (1952)
PRODUCT WATER						
Total Dissolved Solids - mg/L	Column	44.0	334	169	320	14.0
	Overhead	13.0	12.0	15.0	6.4	4.3
P as PO_4 - mg/L	Column	----	170	98.0	----	----
	Overhead	----	0.0	1.3	----	----
Volume - L/Day (gpd)	Column	33 838 (8 940)	33 232 (8 780)	31 605 (8 350)	29 031 (7 670)	27 101 (7 160)
	Overhead	9 500 (2 510)	17 979 (4 750)	17 222 (4 550)	18 433 (4 870)	11 431 (3 020)
	Total	43 338 (11 450)	51 211 (13 530)	48 827 (12 900)	47 464 (12 540)	38 532 (10 180)
HEAT RECOVERY SYSTEM						
Stack Gas In - ^oC (^oF)*		----	----	----	----	----
Stack Gas Out - ^oC (^oF)*		----	----	----	----	----
Steam Use - kg/d (Lbs/Day)		22 906 (50 500)	24 131 (53 200)	22 589 (49 800)	23 950 (52 800)	19 822 (43 700)
ACTUAL OPERATING TIME						
Hrs/Day		3	7	9	3.	1

*Not measured - portable steam boiler in use.

(continued)

TABLE A-7. (continued)

DATA		DATE 6/26	7/9	7/10
RAW CCL WASTE				
Volume Treated - L/Day (gpd)		61 650 (16 288)	58 043 (15 335)	62 203 (16 434)
Total Dissolved Solids - mg/L		11 800	8100	7142
P as PO_4 - mg/L		7340	----	4548
PROCESS BLOWDOWN				
Temperature - ^oC (^oF)		93 (199)	92 (198)	92 (198)
pH		8.2	7.8	7.3
Total Dissolved Solids - mg/L		40 000	40 000	36 000
P as PO_4 - mg/L		15 400	----	19 600
Volume - L/Day (gpd)		18 376 (4855)	11 752 (3105)	12 759 (3371)
PRODUCT WATER				
Total Dissolved Solids - mg/L	Column	605	288	894
	Overhead	358	10.0	10.0
P as PO_4 - mg/L	Column	----	----	472
	Overhead	----	----	0.7
Volume - L/Day (gpd)	Column	30 545 (8 070)	30 386 (8 028)	30 522 (8 064)
	Overhead	12 729 (3 363)	15 942 (4 212)	18 921 (4 999)
	Total	43 274 (11 433)	46 328 (12 230)	49 443 (13 063)
HEAT RECOVERY SYSTEM				
Stack Gas In - ^oC (^oF)*		----	----	.----
Stack Gas Out - ^oC (^oF)*		----	----	----
Steam Use - kg/d (Lbs/Day)		23 950 (52 800)	18 210 (40 146)	25 980 (57 277)
ACTUAL OPERATING TIME				
Hrs/Day		8	2	6

*Not measured - portable steam boiler in use.

TABLE A-8. RAW WASTE AND FEED MAKE-UP ANALYSES - SECOND SERIES OF TESTS (JUNE 2 TO JULY 10, 1975)

Date	pH	Conductivity (µS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
RAW WASTE									
6/3	9.1	1 120	122	55	1 232	1 026	163	480	400
6/4A	9.9	1 825	37	20	2 198	1 790	96	560	560
6/4B	10.3	2 350	71	56	3 298	2 608	164	600	360
6/5	10.1	1 940	93	37	2 464	2 244	183	660	660
6/6	9.6	2 790	52	15	3 772	2 872	171	2 260	2 260
6/11	9.9	2 900	53	15	3 658	2 612	206	1 200	1 120
6/12A	10.0	1 740	29	0	2 164	1 606	124	800	800
6/12B	10.2	5 000	43	9	7 012	5 640	302	2 900	2 400
6/12C	9.9	2 210	19	0	2 678	2 230	135	1 320	1 320
6/26	10.3	9 100	137	32	14 900	11 800	1 200	8 060	7 340
7/10	10.1	6 100	28	10	8 688	7 142	317	4 760	4 540
FEED MAKE-UP									
6/3	6.1	1 240	25	14	1 350	1 202	56	560	400
6/4A	6.1	2 360	276	186	2 852	2 488	98	1 320	1 080
6/4B	6.8	2 250	38	23	2 418	2 044	143	480	360
6/5	6.8	1 975	151	102	2 296	2 042	93	840	840
6/6	6.8	2 550	135	90	2 970	2 550	144	1 340	800
6/11	6.9	2 300	55	12	3 072	2 514	163	1 320	1 320
6/12A	7.2	3 340	34	3	4 420	3 774	63	1 400	1 340
6/12B	6.8	3 950	1 486	1 220	5 840	5 220	132	2 980	2 420
6/12C	2.2	8 800	16	0	6 966	4 664	61	3 040	2 600
6/19	11.1	15 900	1 194	432	25 000	22 100	2 253	7 480	6 680
6/26	6.2	11 600	404	122	15 900	13 800	1 043	6 920	6 700
7/10	6.4	6 600	21	4	8 468	7 298	215	4 900	4 000

TABLE A-9. COLUMN AND OVERHEAD CONDENSATE ANALYSES - SECOND SERIES OF TESTS (JUNE 2 TO JULY 10, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
COLUMN CONDENSATE									
6/3	7.8	58.2	7	6	50	46	3	19.0	19.0
6/4A	7.8	90.0	30	22	124	86	10	21.6	20.4
6/4B	7.0	169.0	28	21	186	130	6	38.6	38.6
6/5	6.5	117.5	24	17	122	86	6	28.8	26.0
6/6	7.1	113.0	15	3	126	90	9	29.0	25.0
6/11	7.4	440.0	17	6	396	334	15	170.0	170.0
6/12A	6.5	134.5	13	2	148	124	14	60.0	48.0
6/12B	6.4	49.0	0	0	62	28	8	36.0	36.0
6/12C	5.8	440.0	10	0	484	356	13	232.0	210.0
7/10	8.2	1 125	30	10	1 160	894	55	664.0	472.0
OVERHEAD CONDENSATE									
6/3	5.7	4.5	5	5	18	18	37	0.8	0.8
6/4A	5.7	3.4	12	10	24	8	17	0.4	0.4
6/4B	5.6	3.9	19	12	20	2	11	1.1	1.1
6/5	4.9	7.0	13	8	12	0	36	0.6	0.6
6/6	---	---	---	---	---	---	87	0.6	0.4
6/11	5.2	4.9	10	2	13	12	14	0.0	0.0
6/12A	5.5	7.7	9	1	16	10	17	2.1	2.1
6/12B	4.9	4.7	0	0	80	8	14	0.6	0.6
6/12C	5.1	9.3	4	0	22	4	73	1.1	1.1
6/26	6.5	17.5	0	0	1 246	358	70	3.1	3.1
7/10	5.2	7.4	0	0	10	10	22	0.7	0.7

TABLE A-10. PROCESS BLOWDOWN ANALYSES - SECOND SERIES OF TESTS (JUNE 2 TO JULY 10, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
6/3	6.8	9 700	9 038	8 164	12 100	11 100	367	5 800	4 200
6/4A	7.7	19 [illegible]	*	*	47 300*	40 500*	924	8 400	3 400
6/4B	8.1	21 500	*	*	41 900*	34 500*	267	9 500	1 800
6/5	5.3	22 500	*	*	50 400*	42 900*	1 056	9 000	2 600
6/6	8.1	19 400	*	*	34 600*	29 200*	1 061	12 500	7 700
6/11	7.1	12 300	*	*	29 100*	18 300*	516	11 600	9 400
6/12A	6.6	20 500	*	*	32 900*	29 700*	649	18 400	16 400
6/12B	6.8	24 500	*	*	43 000*	39 300*	290	25 000	18 000
6/12C	5.8	33 000	*	*	63 300*	57 200*	254	40 000	29 600
6/19	8.1	32 700	*	*	79 600*	54 900*	3 738	31 200	26 000
6/26	8.6	31 000	*	*	59 600*	46 400*	5 318	15 400	15 400
7/10	7.6	26 300	*	*	50 000*	41 400*	1 324	21 000	19 600

*Sample would not filter - reported as total solids.

TABLE A-11. WARRICK PILOT PLANT DATA - THIRD SERIES OF TESTS (SEPTEMBER 3 TO OCTOBER 3, 1975)

DATA		DATE 9/3	9/8	9/9	9/10
RAW CCL WASTE					
Volume Treated - L/Day (gpd)		53 652 (14 175)	71 711 (18 946)	66 858 (17 664)	70 806 (18 707)
Total Dissolved Solids - mg/L		2500	6600	3400	3550
P as PO_4 - mg/L		----	----	1250	360
PROCESS BLOWDOWN					
Temperature - ^{o}C (^{o}F)		94 (201)	92 (198)	92 (198)	93 (200)
pH		6.4	6.9	6.7	6.9
Total Dissolved Solids - mg/L		17 600	22 700	25 550	34 450
P as PO_4 - mg/L		----	----	7900	7850
Volume - L/Day (gpd)		3785 (1000)	20 000 (5284)	7112 (1879)	6317 (1669)
PRODUCT WATER					
Total Dissolved Solids - mg/L	Column	27	20	85	172
	Overhead	5.0	4.3	1.0	5.0
P as PO_4 - mg/L	Column	----	----	53	70.6
	Overhead	----	----	1.8	0.64
Volume - L/Day (gpd)	Column	----	----	----	----
	Overhead	----	----	----	----
	Total	51 306 (13 555)	51 711 (13 662)	59 644 (15 758)	64 489 (17 038)
HEAT RECOVERY SYSTEM					
Stack Gas In - ^{o}C (^{o}F) *		----	----	----	----
Stack Gas Out - ^{o}C (^{o}F) *		----	----	----	----
Steam Use - kg/d (Lbs/Day)		25 391 (55 978)	25 644 (56 536)	34 550 (76 170)	35 517 (78 302)
ACTUAL OPERATING TIME					
Hrs/Day		2	4	8	24

*Not measured - portable steam boiler in use.

(continued)

TABLE A-11. (continued)

DATA		DATE 9/11	9/17	9/18	9/19
RAW CCL WASTE					
Volume Treated - L/Day (gpd)		73 826 (19 505)	76 461 (20 201)	68 781 (18 172)	60 651 (16 024)
Total Dissolved Solids - mg/L		2000	6550	4000	8000
P as PO_4 - mg/L		1000	3450	----	----
PROCESS BLOWDOWN					
Temperature - ^{o}C (^{o}F)		91 (196)	92 (198)	91 (196)	90 (194)
pH		7.1	7.3	7.0	7.6
Total Dissolved Solids - mg/L		20 800	29 250	19 500	32 200
P as PO_4 - mg/L		9700	8150	4700	4150
Volume - L/Day (gpd)		9584 (2532)	16 033 (4236)	16 003 (4228)	13 577 (3587)
PRODUCT WATER					
Total Dissolved Solids - mg/L	Column	198	10	6.1	3.3
	Overhead	22	0	4.1	3.5
P as PO_4 - mg/L	Column	90	6.4	----	----
	Overhead	0.6	1.3	----	----
Volume - L/Day (gpd)	Column	----	----	----	----
	Overhead	----	----	----	----
	Total	64 243 (16 973)	60 428 (15 965)	52 778 (13 944)	47 074 (12 437)
HEAT RECOVERY SYSTEM					
Stack Gas In - ^{o}C (^{o}F) *		----	----	----	----
Stack Gas Out - ^{o}C (^{o}F) *		----	----	----	----
Steam Use - kg/d (Lbs/Day)		41 657 (91 838)	36 132 (76 658)	30 764 (67 824)	24 755 (54 576)
ACTUAL OPERATING TIME					
Hrs/Day		16	19	20	8

*Not measured - portable steam boiler in use.

(continued)

TABLE A-11. (continued)

DATA		DATE 9/22	9/23	9/24	9/25
RAW CCL WASTE					
Volume Treated - L/Day (gpd)		83 815 (22 144)	67 002 (17 701)	60 708 (16 039)	78 698 (20 792)
Total Dissolved Solids - mg/L		6900	4700	3200	3400
P as PO_4 - mg/L		----	3500	----	----
PROCESS BLOWDOWN					
Temperature - ^{o}C (^{o}F)		92 (198)	91 (196)	91 (195)	92 (197)
pH		6.6	6.5	6.4	6.2
Total Dissolved Solids - mg/L		24 000	33 700	36 100	19 900
P as PO_4 - mg/L		----	14 700	16 100	12 000
Volume - L/Day (gpd)		25 390 (6708)	9175 (2424)	5129 (1355)	16 529 (4367)
PRODUCT WATER					
Total Dissolved Solids - mg/L	Column	5.9	0.0	5.3	0.0
	Overhead	4.3	16	36	28
P as PO_4 - mg/L	Column	----	5.7	----	0.5
	Overhead	----	1.4	2.8	1.6
Volume - L/Day (gpd)	Column	----	----	----	----
	Overhead	----	----	----	----
	Total	58 433 (15 438)	57 823 (15 277)	55 579 (14 684)	62 169 (16 425)
HEAT RECOVERY SYSTEM					
Stack Gas In - ^{o}C (^{o}F) *		----	----	----	----
Stack Gas Out - ^{o}C (^{o}F) *		----	----	----	----
Steam Use - kg/d (Lbs/Day)		26 751 (58 976)	28 674 (63 215)	27 205 (59 976)	30 578 (67 413)
ACTUAL OPERATING TIME					
Hrs/Day		4	17	24	17

*Not measured - portable steam boiler in use.

(continued)

TABLE A-11. (continued)

DATA		DATE 9/30	10/1	10/2	10/3
RAW CCL WASTE					
Volume Treated - L/Day (gpd)		79 065 (20 889)	76 680 (20 259)	74 337 (19 640)	74 920 (19 794)
Total Dissolved Solids - mg/L		5400	5400	5900	4100
P as PO_4 - mg/L		----	----	2900	580
PROCESS BLOWDOWN					
Temperature - ^{o}C (^{o}F)		92 (198)	92 (198)	92 (198)	92 (198)
pH		6.7	6.5	7.0	6.7
Total Dissolved Solids - mg/L		23 500	30 100	35 150	23 450
P as PO_4 - mg/L		----	14 200	11 100	5400
Volume - L/Day (gpd)		17 589 (4647)	12 926 (3415)	11 934 (3153)	14 989 (3960)
PRODUCT WATER					
Total Dissolved Solids - mg/L	Column	4.0	10.0	0	7.0
	Overhead	3.5	10.0	0	5.3
P as PO_4 - mg/L	Column	----	1.2	1.5	----
	Overhead	----	1.1	0.5	----
Volume - L/Day (gpd)	Column	----	----	----	----
	Overhead	----	----	----	----
	Total	61 476 (16 242)	63 755 (16 844)	62 403 (16 487)	59 932 (15 834)
HEAT RECOVERY SYSTEM					
Stack Gas In - ^{o}C (^{o}F)*		----	----	----	----
Stack Gas Out - ^{o}C (^{o}F)*		----	----	----	----
Steam Use - kg/d (Lbs/Day)		27 839 (61 375)	31 376 (69 172)	30 650 (67 573)	30 469 (67 173)
ACTUAL OPERATING TIME					
Hrs/Day		3	24	24	10

*Not measured - portable steam boiler in use.

TABLE A-12. WARRICK PILOT PLANT DATA - THIRD SERIES OF TESTS (SEPTEMBER 3 TO OCTOBER 3, 1975)

	9/3	9/8	9/9	9/10
Flow Rates				
Air to Column - m^3/min (SCFM)	14 (500)	21 (750)	26 (912)	26 (933)
Column Feed - L/min (gpm)	409 (108)	394 (104)	379 (100)	379 (100)
Feed Tap-Off to Settling Tank - L/min (gpm)	11 (3)	11 (3)	11 (3)	11 (3)
Temperatures - ^oC (^oF)				
Ambient	---	24 (75)	---	23 (74)
Raw CCL Waste	61 (142)	60 (140)	63 (145)	62 (143)
Air to Column	53 (127)	53 (127)	49 (121)	51 (123)
Column Feed	80 (176)	81 (177)	78 (172)	80 (176)
Column Blowdown	94 (201)	92 (198)	92 (198)	93 (200)
Vapors - Column Bottom	94 (202)	93 (199)	94 (201)	94 (201)
Column Condensate	97 (206)	90 (194)	94 (202)	94 (202)
Overhead Vapor	87 (189)	83 (181)	86 (186)	83 (181)
Overhead Condensate	49 (120)	48 (119)	53 (128)	59 (139)
Steam Condensate	102 (216)	101 (214)	103 (217)	104 (219)
Water Out Heat Exchanger	74 (166)	74 (166)	71 (160)	71 (159)
Pressures - kPa (in. H_2O)				
Air to Column	8.2 (33.0)	7.6 (30.5)	12.2 (49.0)	13.4 (54.0)
Demister Loop-Bottom	2.0 (8.0)	2.5 (10.0)	4.1 (16.5)	5.4 (21.5)
Demister Loop-Top	1.1 (4.5)	0.1 (4.0)	3.7 (14.8)	5.2 (20.8)
Overhead Vapor	0.5 (2.0)	0.9 (3.5)	1.5 (6.0)	2.1 (8.4)
Steam to Column	10.5 (42.0)	2.4 (9.5)	12.7 (51.0)	14.0 (56.2)
Feed Pump-Discharge - kPa (psig)	434 (63.0)	427 (62.0)	441 (64.0)	431 (62.5)
Production				
Total Condensate - L/d (gpd)	51 306 (13 555)	51 711 (13 662)	59 720 (15 778)	64 489 (17 038)
Process Blowdown - L/d (gpd)	3 785 (1 000)	20 000 (5 284)	7 112 (1 879)	6 317 (1 669)
Waste Treated - L/d (gpd)	53 652 (14 175)	71 711 (18 946)	66 858 (17 664)	70 806 (18 707)
Steam Used - kg/d (Lbs/Day)	25 395 (55 987)	25 644 (56 536)	34 550 (76 170)	35 517 (78 302)

(continued)

TABLE A-12.(continued)

	9/11	9/17	9/18	9/19
Flow Rates				
Air to Column - m^3/min (SCFM)	26 (925)	24 (851)	24 (864)	25 (867)
Column Feed - L/min (gpm)	379 (100)	397 (105)	397 (105)	397 (105)
Feed Tap-Off to Settling Tank - L/min (gpm)	11 (3)	11 (3)	11 (3)	11 (3)
Temperatures - ^{o}C (^{o}F)				
Ambient	21 (69)	---	22 (71)	20 (68)
Raw CCL Waste	47 (116)	47 (134)	61 (142)	61 (142)
Air to Column	49 (120)	48 (118)	47 (116)	49 (120)
Column Feed	81 (177)	80 (176)	76 (168)	73 (163)
Column Blowdown	91 (196)	92 (198)	91 (196)	90 (194)
Vapors - Column Bottom	92 (197)	93 (200)	96 (205)	91 (195)
Column Condensate	93 (200)	92 (197)	91 (195)	88 (191)
Overhead Vapor	83 (182)	84 (184)	83 (181)	78 (172)
Overhead Condensate	57 (135)	53 (128)	46 (115)	42 (107)
Steam Condensate	104 (219)	106 (222)	102 (215)	103 (217)
Water Out Heat Exchanger	69 (156)	68 (154)	56 (132)	51 (124)
Pressures - kPa (in. H_2O)				
Air to Column	14.8 (59.5)	14.7 (59.0)	11.9 (48.0)	12.4 (50.0)
Demister Loop-Bottom	5.8 (23.4)	5.0 (20.2)	4.3 (17.2)	3.3 (13.4)
Demister Loop-Top	5.6 (22.7)	4.6 (18.3)	3.9 (15.7)	2.8 (11.3)
Overhead Vapor	2.2 (9.0)	1.9 (7.7)	1.6 (6.6)	1.4 (5.5)
Steam to Column	15.5 (62.3)	20.0 (80.3)	15.2 (60.9)	11.3 (45.5)
Feed Pump-Discharge - kPa (psig)	434 (63.0)	431 (62.5)	431 (62.5)	434 (63.0)
Production				
Total Condensate - L/d (gpd)	64 243 (16 973)	60 428 (15 965)	52 778 (13 944)	47 074 (12 437)
Process Blowdown - L/d (gpd)	9 584 (2 532)	16 033 (4 236)	16 003 (4 228)	13 577 (3 587)
Waste Treated - L/d (gpd)	73 826 (19 505)	76 461 (20 201)	68 781 (18 172)	60 651 (16 024)
Steam Used - kg/d (Lbs/Day)	41 657 (91 838)	36 132 (79 658)	30 764 (67 824)	24 755 (54 576)

(continued)

TABLE A-12. (continued)

	9/22	9/23	9/24	9/25
Flow Rates				
Air to Column - m^3/min (SCFM)	24 (850)	24 (860)	24 (863)	24 (834)
Column Feed - L/min (gpm)	397 (105)	397 (105)	397 (105)	397 (105)
Feed Tap-Off to Settling Tank - L/min (gpm)	11 (3)	11 (3)	11 (3)	11 (3)
Temperatures - ^{o}C (^{o}F)				
Ambient	12 (54)	12 (54)	12 (53)	11 (51)
Raw CCL Waste	39 (103)	56 (133)	60 (140)	58 (137)
Air to Column	41 (105)	40 (104)	37 (99)	37 (99)
Column Feed	82 (180)	83 (182)	84 (183)	85 (185)
Column Blowdown	92 (198)	91 (196)	91 (195)	92 (197)
Vapors - Column Bottom	93 (199)	93 (199)	92 (197)	93 (199)
Column Condensate	90 (194)	90 (194)	90 (194)	92 (198)
Overhead Vapor	84 (183)	83 (182)	83 (181)	85 (185)
Overhead Condensate	46 (114)	46 (115)	46 (114)	48 (118)
Steam Condensate	102 (215)	102 (216)	102 (216)	101 (213)
Water Out Heat Exchanger	48 (118)	35 (95)	---	---
Pressures - kPa (in. H_2O)				
Air to Column	13.7 (55.0)	14.2 (57.0)	13.9 (56.0)	14.2 (57.0)
Demister Loop-Bottom	>8.7 (>35.0)	>8.7 (>35.0)	>8.7 (>35.0)	>8.7 (>35.0)
Demister Loop-Top	1.7 (3.0)	3.0 (12.0)	4.9 (19.8)	5.7 (23.0)
Overhead Vapor	1.6 (6.5)	1.9 (7.7)	2.0 (8.0)	2.0 (8.2)
Steam to Column	12.1 (48.5)	11.0 (44.3)	10.4 (41.6)	7.6 (30.5)
Feed Pump-Discharge - kPa (psig)	431 (62.5)	438 (63.5)	438 (63.5)	438 (63.5)
Production				
Total Condensate - L/d (gpd)	58 433 (15 438)	57 823 (15 277)	55 579 (14 684)	62 169 (16 452)
Process Blowdown - L/d (gpd)	25 390 (6 708)	9 175 (2 424)	5 129 (1 355)	16 529 (4 367)
Waste Treated - L/d (gpd)	83 815 (22 144)	66 998 (17 701)	60 708 (16 039)	78 698 (20 792)
Steam Used - kg/d (Lbs/Day)	26 751 (58 976)	28 674 (63 215)	27 205 (59 976)	30 578 (67 413)

(continued)

TABLE A-12. (continued)

	9/30	10/1	10/2	10/3
Flow Rates				
Air to Column - m^3min (SCFM)	25 (866)	25 (867)	25 (870)	25 (875)
Column Feed - L/min (gpm)	397 (105)	397 (105)	397 (105)	397 (105)
Feed Tap-Off to Settling Tank - L/min (gpm)	11 (3)	11 (3)	11 (3)	0 (0)
Temperatures - ^{o}C (^{o}F)				
Ambient	20 (68)	13 (56)	9 (49)	6 (43)
Raw CCL Waste	56 (132)	57 (134)	51 (123)	52 (125)
Air to Column	48 (118)	41 (105)	37 (98)	37 (98)
Column Feed	85 (185)	86 (186)	85 (185)	85 (185)
Column Blowdown	92 (198)	92 (198)	92 (198)	92 (198)
Vapors - Column Bottom	93 (199)	93 (199)	93 (200)	93 (200)
Column Condensate	91 (195)	92 (198)	92 (197)	92 (198)
Overhead Vapor	85 (185)	85 (185)	84 (184)	84 (184)
Overhead Condensate	56 (132)	51 (124)	47 (117)	44 (112)
Steam Condensate	101 (213)	101 (213)	101 (214)	102 (215)
Water Out Heat Exchanger	---	---	---	---
Pressures - kPa (in. H_2O)				
Air to Column	13.7 (55.0)	14.4 (58.0)	14.7 (59.0)	14.9 (60.0)
Demister Loop-Bottom	>8.7 (>35.0)	---	5.2 (21.0)	5.2 (21.0)
Demister Loop-Top	---	---	4.7 (19.0)	4.2 (17.0)
Overhead Vapor	2.1 (8.5)	2.1 (8.5)	2.0 (8.0)	2.1 (8.5)
Steam to Column	---	---	---	5.6 (22.5)
Feed Pump-Discharge - kPa (psig)	431 (62.5)	438 (63.5)	438 (63.5)	438 (63.5)
Production				
Total Condensate - L/d (gpd)	61 476 (16 242)	63 755 (16 844)	62 403 (16 487)	59 932 (15 834)
Process Blowdown - L/d (gpd)	17 589 (4 647)	12 926 (3 415)	11 934 (3 153)	14 989 (3 960)
Waste Treated - L/d (gpd)	79 065 (20 889)	76 680 (20 259)	74 337 (19 640)	74 920 (19 794)
Steam Used - kg/d (Lbs/Day)	27 839 (61 375)	31 376 (69 172)	30 650 (67 573)	30 468 (67 170)

TABLE A-13. RAW WASTE AND FEED MAKE-UP ANALYSES - THIRD SERIES OF TESTS (SEPTEMBER 3 TO OCTOBER 3, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
RAW WASTE									
9/9A	9.9	2 100	120	30	2 500	2 100	242	1 100	600
9/9B	10.0	2 525	20	2	2 700	2 300	70	1 200	1 100
9/10A	10.1	3 500	54	19	4 300	3 500	155	1 700	1 600
9/10B	10.2	4 700	39	21	6 000	5 100	143	3 600	2 100
9/11	10.0	2 600	33	13	2 800	2 300	74	1 100	800
9/17A	10.0	2 008	53	10	3 200	2 500	177	1 800	1 800
9/17B	10.1	3 075	41	18	3 600	2 900	173	9 900	9 200
9/18	9.7	1 115	52	10	1 100	860	90	500	450
9/19	10.6	6 400	74	39	8 700	7 300	228	9 600	9 600
9/23	10.1	4 480	54	13	5 700	4 800	228	3 300	3 100
FEED MAKE-UP									
9/9A	6.4	3 380	49	16	4 200	3 500	150	1 800	1 500
9/9B	6.4	3 300	30	6	3 900	3 300	101	1 200	1 100
9/10A	6.6	2 100	34	12	2 600	2 100	121	1 100	360
9/10B	7.5	4 600	42	22	5 900	5 000	150	----	----
9/11	9.6	2 150	43	14	2 400	2 000	68	1 200	1 000
9/17A	6.8	5 120	163	21	8 200	6 700	319	3 400	3 100
9/17B	6.9	5 210	452	63	9 300	6 400	561	3 800	3 400
9/18	4.5	3 020	408	284	3 200	2 600	83	709	68
9/19	7.0	12 600	109	46	18 000	14 800	539	10 400	9 300
9/23	6.0	6 100	164	29	5 300	4 700	169	3 500	3 500
10/2	4.1	5 800	74	21	7 500	5 900	239	2 900	2 900
10/3A	5.8	3 900	58	4	4 200	3 500	166	8 500	550
10/3B	6.5	5 200	98	9	5 500	4 700	194	950	610

TABLE A-14. COLUMN AND OVERHEAD CONDENSATE ANALYSES - THIRD SERIES OF TESTS (SEPTEMBER 3 TO OCTOBER 3, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
COLUMN CONDENSATE									
9/9A	6.9	93.9	0	0	80	62	13	60.0	58.0
9/9B	7.2	157.0	0	0	148	108	12	58.0	48.0
9/10A	7.0	140.0	0	0	124	90	7	80.0	40.0
9/10B	7.2	299.0	10	7	292	244	15	111.0	101.2
9/11	7.9	220.0	129	123	248	198	8	97.0	90.0
9/17	7.6	244.0	0	0	50	10	8	6.4	6.4
9/23*	5.8	11.9	0	0	24	0	7	5.7	5.7
9/25	5.1	5.0	1	0	0	0	29	4.5	0.5
10/1	5.4	7.3	2	0	10	10	13	1.3	1.2
10/2	6.1	9.8	7	1	22	0	6	1.8	1.5
OVERHEAD CONDENSATE									
9/9A	5.4	5.8	0	0	16	2	50	2.3	1.6
9/9B	6.0	12.3	0	0	10	0	17	2.0	2.0
9/10A	5.3	6.5	0	0	0	0	41	0.8	0.8
9/10B	6.0	4.5	2	1	20	10	10	0.6	0.5
9/11	5.8	3.7	5	2	22	22	17	0.6	0.6
9/17	5.8	7.8	0	0	26	0	11	1.3	1.3
9/23	5.3	6.1	0	0	28	16	26	1.4	1.4
9/24	5.4	15.1	0	0	38	36	46	7.7	2.8
9/25	5.3	7.6	3	0	28	28	11	2.5	1.6
10/1	5.5	16.5	5	1	14	10	44	1.2	1.1
10/2	5.2	4.3	3	0	182	0	25	0.6	0.5

*Demister replaced in Thermopure column.

TABLE A-15. PROCESS BLOWDOWN ANALYSES - THIRD SERIES OF TESTS (SEPTEMBER 3 TO OCTOBER 3, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
9/9A	6.5	15 000	*	*	25 600*	21 700*	577	11 600	8 000
9/9B	6.4	18 900	*	*	34 000*	29 400*	532	8 000	7 800
9/10A	6.5	21 000	*	*	42 400*	36 300*	317	13 200	4 800
9/10B	6.4	21 500	*	*	38 100*	32 600*	280	15 500	10 900
9/11	7.1	16 000	*	*	24 900*	20 800*	300	12 900	9 700
9/17A	7.1	13 500	*	*	29 500*	24 500*	864	13 100	8 900
9/17B	8.1	13 800	*	*	42 500*	34 000*	2 127	13 700	7 400
9/18	7.0	17 500	*	*	23 400*	19 500*	1 019	5 100	4 700
9/19A	7.5	21 750	*	*	36 800*	30 900*	5 596	8 700	2 700
9/19B	8.7	20 400	*	*	39 500*	33 500*	498	5 600	5 600
9/23A	6.4	21 400	*	*	40 800*	33 700*	491	16 200	14 700
9/24	6.1	20 750	*	*	43 300*	36 100*	807	17 600	16 100
9/25	6.1	23 400	4 271	3 521	23 800	19 900	501	14 300	12 000
10/1	6.8	24 500	*	*	37 000*	30 100*	502	15 300	14 200
10/2A	6.3	23 250	*	*	43 800*	35 900*	39	18 200	15 800
10/2B	6.5	23 500	*	*	40 000*	34 400*	108	16 900	6 400
10/3A	7.0	17 500	*	*	29 200*	24 700*	669	17 600	5 200
10/3B	6.6	20 500	*	*	38 800*	32 200*	1 109	25 100	5 600

*Sample could not be filtered - reported as total solids.

TABLE A-16. COMBINED COLUMN AND OVERHEAD CONDENSATE ANALYSES - THIRD SERIES OF TESTS (SEPTEMBER 3 TO OCTOBER 3, 1975)

Date	pH	Conductivity (μS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
9/17A	6.9	90.0	0	0	36	24	10	3.0	3.0
9/17B	4.9	28.8	0	0	46	14	25	2.4	2.4
9/18	5.7	8.9	10	4	8	0	23	1.9	1.9
9/19A	4.2	29.0	0	0	24	12	8	1.1	1.1
9/19B	5.7	5.2	7	3	0	0	10	0.7	0.4
9/23A	6.0	10.7	0	0	10	10	---	4.3	4.3
9/23B	---	---	---	---	---	---	29	---	---
9/24	5.3	7.7	0	0	20	8	---	0.5	0.1
10/2	5.6	6.0	10	5	38	4	---	2.5	2.5
10/3A	5.8	6.9	10	0	40	0	19	0.8	0.3
10/3B	6.0	15.3	21	0	66	0	30	0.6	0.2

TABLE A-17. COMBINED CONDENSATE ANALYSES AFTER OIL SEPARATION AND AFTER ACTIVATED CARBON ADSORPTION - THIRD SERIES OF TESTS (SEPTEMBER 3 TO OCTOBER 3, 1975)

Date	pH	Conductivity (µS)	Suspended Solids at 105°C (mg/L)	Suspended Solids at 500°C (mg/L)	Dissolved Solids at 105°C (mg/L)	Dissolved Solids at 500°C (mg/L)	Oil (mg/L)	Phosphorous as PO_4 Total (mg/L)	Phosphorous as PO_4 Dissolved (mg/L)
AFTER MECHANICAL OIL SEPARATOR									
9/17A	5.9	40.2	5	0	28	10	7	1.6	1.6
9/17B	9.1	42.5	2	1	43	18	22	1.8	1.8
9/18	5.9	6.3	11	6	38	14	18	1.9	1.5
9/19A	5.9	5.4	10	4	2	0	7	1.0	1.0
9/19B	6.2	15.9	7	0	24	10	7	1.7	1.7
9/23A	5.9	6.8	4	0	12	12	---	2.2	2.2
9/23B	---	---	---	---	---	---	22	---	---
9/24	5.1	10.2	0	0	18	18	25	2.5	2.3
9/25	5.6	5.7	6	3	10	10	13	1.0	1.0
10/2A	5.6	6.5	11	0	30	0	5	1.1	0.9
10/2B	5.7	5.2	8	2	16	0	---	1.0	0.9
10/3A	5.9	5.7	8	0	32	0	14	1.3	1.3
10/3B	5.8	8.3	16	0	22	0	22	1.9	1.9
AFTER ACTIVATED CARBON TREATMENT									
9/17A	5.7	68.8	0	0	20	18	1	0.8	0.8
9/17B	4.5	38.3	0	0	48	14	9	4.3	4.3
9/18	5.5	5.8	10	7	16	2	11	0.5	0.1
9/19A	6.0	7.6	9	0	52	2	6	1.0	0.2
9/19B	8.6	33.8	0	0	52	14	6	0.4	0.4
9/23A	6.4	6.7	0	0	20	8	---	0.4	0.4
9/23B	---	---	---	---	---	---	13	---	---
9/24	6.1	7.5	0	0	14	14	20	0.9	0.9
9/25	6.1	30.7	2	1	0	2	11	0.6	0.5
10/2A	6.2	5.5	2	0	0	0	13	0.6	0.5
10/2B	6.2	4.5	7	3	20	0	---	0.5	0.5
10/3A	6.0	7.3	7	0	18	0	8	1.1	1.1
10/3B	6.3	8.2	23	0	76	18	9	2.8	2.8